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A LABORATORY EQUIPMENT FOR STIFF-MUD TESTS, INCLUDING EXHAUSTION OF THE AIR[1]

By Ellis Lovejoy and H. E. CoVan

ABSTRACT

A small auger machine is described for laboratory use in testing stiff-mud clays with special reference to de-airing the clays and for investigation of augers, dies, and various devices which affect the flow of stiff-mud clay.

I. Introduction

Figure 1 shows a small auger machine for the laboratory testing of stiff-mud clays. The initial purpose of the machine was to de-air the clay in its passage through the machine and to get a comparison of the flow behavior, the strength, and the laminations of the clay not de-aired and de-aired. A further purpose was to investigate various devices which affect the flow of the clay.

Many tests have been made with different augers and various devices between the auger and die but solely for the purpose of getting the best bar possible for the tests under normal atmospheric conditions and under vacuum.

II. The Machine

The central feature of the machine is a $2^1/_2$-inch *T* into which is screwed a 6-inch nipple[2] for the machine barrel and extension ring. The length of the barrel can be varied with nipples to get as much or as little extension-ring space between the auger and the die as may be desired.[2]

(1) Form Back of Die A simple form, shown in Fig. 1, which gradually brings the clay down to the die entrance was the best for the present tests. Prior to putting in this form, in place of which there was a square shoulder on which the clay built up its own form, some clays not de-aired would tear on the corners and have roughened (furred) surfaces. Back pressure on the column overcame this tearing, but with the use of the form there has been no trouble with torn corners even without back pressure.[3]

(2) The Barrel The end of the barrel is closed by a cap through which is inserted the die secured by a lock-nut. In the rear of the machine is a reducing plug fitted with a $1^1/_2$-inch nipple about 5 inches

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division).

[2] Five-inch nipples were used first and then changed to 6-inch, which gives space for inserting devices.

[3] De-aired clays, even without the form, gave no trouble with torn corners in the column. The difference in the columns, de-aired and not de-aired, was very apparent. This was the first evidence of the value of de-airing the clay.

long, provided with a cap and packing gland as shown. After the shaft was centered in the machine[4] the rear nipple was babitted to make a long bearing.

The barrel has a fluted liner to hold the clay from turning with the auger.

(3) Adaptability The machine as above assembled is used for ordinary testing where the quantity of clay is too small for a larger outfit. The machine is quickly taken apart for cleaning, simply

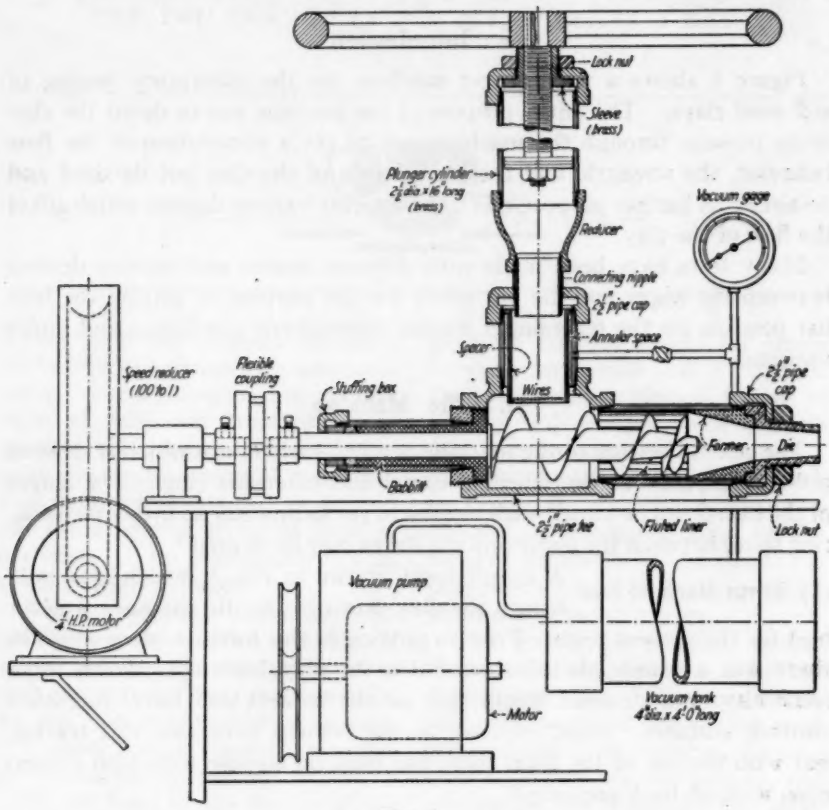

FIG. 1.

by removing the die cap, loosening the set screw in the flange coupling, and slipping out the auger shaft.

III. De-Airing Attachment

De-airing tests require the additional equipment shown in the upper part of Fig. 1. A nipple is screwed into the machine T and inside this is a

[4] The shaft is connected to a 100:1 speed reducer through a flange flexible coupling. The power requirement is a $\frac{1}{4}$-h.p. motor with a speed around 1700 r.p.m., which gives the shaft a speed of 17 r.p.m.

spacer which gives an annular space through which the air is drawn off. The spacer extends down to just clear the auger and in the lower end of it a number of wires are inserted to cut the clay into ribbons for better extraction of the air.

Into the spacer nipple cap is screwed a $1^1/_2$-inch short nipple called the neck. Above this is a reducer into which is screwed a plunger cylinder or gun akin to an Alemite grease gun.

The die can be used on the gun in a horizontal position for which clamps on the table are provided and it also can be used on the de-airing attachment with the gun for tests comparing auger and piston pressures. The same die cap fits the de-airing equipment and a separate cap with finer thread is provided for the gun alone.

The annular space above mentioned is connected to a vacuum gage and a vacuum tank made of 4-inch pipe and having a capacity of 3 gallons which is ample for the purpose. The tank connects with a Cenco vacuum pump.

After the clay starts to flow through the machine die in the de-airing tests, the machine barrel is sealed by the column in the die, the plug in the neck, and the stuffing box in the rear.

IV. Making De-Airing Tests

In making the de-airing tests, the air in the tank is exhausted to a gage reading of 27 to 29 inches. Meanwhile the machine is started to fill the barrel and force the column through the die, after which the exhaust is connected for the tests.

The first bars coming through the die are rejected. The gun holds enough clay for these rejects, for a dozen 1-inch bars $4^1/_2$ inches long, and excess to leave the machine barrel full. During de-airing there is no trouble in maintaining a vacuum of 25 inches. If the gage reading falls below 25 inches there is some leak in the connection which must be located and stopped.

In addition to the improvement in the de-aired column compared with the column not de-aired prior to putting the form in the barrel, there is a notable difference in the appearance of the bars. The bars not de-aired have a grainy appearance and occasionally blister. The surfaces of the de-aired bars are smooth, dense, and free from any flaws.[5]

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[5] Numerous tests were made with different augers and various devices in the extension space in standardizing the machine. In all of them the bars would slightly warp in drying. This was attributed to the twisting movement given to the clay by the auger. Although the die was not suspected as being the cause of the trouble, it was decided to make a new die (entirely machine made). The original die had been finished by hand. The new die corrected the trouble.

V. Results Obtained

These first tests are not comparable because of changes in the machine, but without exception there was an increase in the transverse modulus of the de-aired bars. (The work was interrupted for nearly a year at this time.) After the first test the remaining pugged clay was put in a tight can and allowed to age. It actually became moldy.

A recent test of this clay is given as follows:

		(%)
Water of plasticity	Air	29.1
	Vacuum	28.6
Drying shrinkage	Air	8.44
	Vacuum	8.21
Bulk specific gravity	Air	1.956
	Vacuum	1.975
Transverse rupture moduli	Air	896
	Vacuum	1164
Gain		29.9

The same clay, same pug, when tested a year before had the following moduli of transverse rupture:

Air	838
Vacuum	1065

These are not wholly comparable because of the change in the die and auxiliary equipment.

(1) Bedford Shale Tests Two samples of Bedford shale were taken from the same pit but with an interval of one year or more in the working of the pit. In the last test in the No. 3 series and Series 4, 5, and 6, the new die was used. The tests in Series 1 and 2 and the first two of No. 3 are not fully comparable, but there is not much

BEDFORD SHALE

(Blue shale predominating)

		Pug	Aged	Water plasticity (%)	Shrinkage (%)	Specific gravity	Modulus	Gain (%)
1	Air	W. P.		24.05	4.82		428	
	Vacuum			23.70	5.84		507	18.0
	Air		7 days	24.90	5.10	2.007	420	
	Vacuum			23.70	5.96	2.054	485	15.5
2	Air	W. P.		26.20	4.5?		515	
	Vacuum			25.60	6.6		574	11.5
3*	Air	W. P.		22.4		1.92	441	
	Vacuum			23.2	5.02	1.96	524	18.9
	Air			22.8	4.79	1.92	446	
	Vacuum			22.5	5.84	1.96	488	9.4
	Air		12 days	23.3	6.20	2.045	483	
	Vacuum			23.2	6.25	2.062	516	6.9
4	Air	P. M.		23.1	5.23	1.989	301	
	Vacuum			22.8	5.73	2.066	360	19.6
	Air		14 days	23.5	5.58	2.017	335	
	Vacuum			23.1	5.97	2.064	398	18.8

* For reference, see p. 537.

BEDFORD SHALE

(Containing red shale)

5	Air	W. P.		22.6	4.53	1.945	363	
	Vacuum			22.5	4.84	2.018	432	19.0
	Air		8 days	22.6	4.23	2.043	369	
	Vacuum			22.6	4.77	2.096	436	18.1
6	Air	P. M.		23.0	4.14	2.038	306	
	Vacuum			23.1	4.99	2.108	368	20.2
	Air		7 days	21.9	5.10	2.066	334	
	Vacuum			22.2	5.57	2.125	349	4.5

* New die and standard equipment in the last tests of No. 3 and Nos. 4, 5, and 6.
P. M. is pugmill pugging.
W. P. is wet-pan pugging.

difference. In Series 3, moduli 441 and 524 were obtained with one device, 446 and 488 with the second device, and 483 and 516 with the standard rig. They were all the same pug but the third member in the series was aged seven days which added to its strength. Aging for a period of one week increased the strength but not much, as the several tests show.

Each series in the tests as numbered used the same pugged mass of clay which for the repeat tests was aged as stated. Each pair is not only the same pug but the two tests followed one another within a few minutes.

A few things consistently stand out in the tests. In every instance de-airing the clay has resulted in a higher transverse modulus in the dry ware, averaging around 15% increase. In every test in which the bulk specific gravities were determined there is a small increase in the specific gravity of the de-aired bars. In every test the de-aired bars have higher linear shrinkage.

Wet-pan pugging gives stronger ware than pugmill pugging. This is subject to further tests.

There is one inconsistency in the tests. The blue Bedford shale first tested is notably stronger than the red shale (both wet-pan pugged), but this does not hold true in the pugmill pugging as a comparison of tests 4 and 6 shows, nor is this inconsistency related to the water content. The water contents in 4 and 6 are closely alike. There may be a wide variation in the degree of pugmill pugging.

The quantity of water used in pugging has a notable effect on the strength of the dry ware and this is a weak point in the bonding tests as usually carried out. To get satisfactory results in comparative bonding tests each clay should be tested in series with increasing quantities of water until the best result is obtained. This result compared with another clay similarly tested would have comparative value. The higher results in the No. 2 tests in the table likely are due to the higher water content and softer pugged mass.

The plastic shale first mentioned which requires about 30% of water to make it workable could not be compared with the Bedford shale with

22 to 25% of water which the Bedford requires, nor could this shale be compared with Bedford containing 30% of water.

(2) Two Plastic Bond Clays One clay, designated as "A," stays in suspension in water. It is easily washed through a 200-mesh sieve, leaving a residue of 0.5% chiefly quartz, some mica, etc.

The other, designated as "B," settles quickly in water and is difficult to wash through the sieve. It had to be soaked, boiled, and finally rubbed through the sieve with the finger tips, leaving but a few grains of quartz.

The water of plasticity (for stiff-mud products) of "A" is around 30% and for "B" around 38%. The latter has a long pugging range. Tests were run with water contents of 40%, 41%, and as high as 43%. The last mentioned was a bit soft but it was not sticky and the ware could be handled. Tests were run with as low as 37% water and undoubtedly less could have been used with the mass workable.

The differences in the water content led to the assumption that "B" was finer grained (more colloidal) than "A" and other things being equal it should have greater strength as a bonding material.

The tests show such not to be the case and indicate that differences in degree of flocculation are contributing factors in the bonding strength.

TEST OF CLAY "A"

		Modulus	Gain (%)	Water (%)	Shrinkage (%)	Sp. gr.	Treatment
1	Air	527		29.8	7.47	1.884	
	Vacuum	796	51.0	30.7	8.03	1.941	
2	Air	355		29.8	6.61	1.853	Added 1% HCl to
	Vacuum	567	59.7	29.7	7.52	1.878	pug water
3	Air	648		31.0			No. 2 pug aged 24
	Vacuum	725	11.9	30.7			days
4	Air	804		29.1	6.31		Added 1% NaOH
	Vacuum	1294	60.9	29.3	6.8		to pug water
5	Air	1050		28.4			No. 4 pug aged 21
	Vacuum	1364	30.0	28.5			days

The No. 4 and No. 5 series were repeated on a different pug with less NaOH with the following result: as pugged, air 815, vacuum 1071. After aging 14 days the results were air 850, vacuum 1148.

The addition of the acid (No. 2) makes a notable drop in the strength which was to be expected from flocculation if the clay was deflocculated or partly deflocculated as the washing tests indicated.

Aging the acid-treated clay brings the clay fully back to its initial strength of untreated clay, though a test of the aged acid-treated clay shows that it is still acid. The addition of soda increased the strength in greater degree than the acid decreased the strength.

One thing that stands out in all the tests is that aged clay shows less gain of the vacuum bar strengths over the air bar strengths than with the

unaged clay. Note that No. 2 which is unaged drops from 59.7 to 11.9% in the No. 3 aged tests. Similarly No. 4 and No. 5 drop from 60.9 to 30%. The higher figures in the aged tests which make the percentages lower do not account for the drop. Only in two instances in the Bedford shale tests, where the vacuum bars had but slight increase over the air bars, can the decrease in percentage gain by the increase in plasticity due to aging be accounted for.

It seems evident that aging in some way eliminates some of the air and this air elimination may be the explanation of the improvement in aging clay instead of merely increased plasticity.

It is seen in repeated instances that de-aired freshly pugged clay develops greater strength than the aged clay not mechanically de-aired. This is true in all the tests except the acid-treated clay in the series of the "A" clay, and a subsequent fireclay test in which the pug was aged five weeks.

TESTS OF "B" CLAY

		Modulus	Gain (%)	Water (%)	Shrinkage (%)	Sp. gr.	Treatment
1	Air	350		38.8	8.76	1.800	
	Vacuum	471	34.6	40.9	9.52	1.805	
2	Air	392		37.2			Added 1% HCl to pug water
	Vacuum	556	41.8	37.6			
3	Air	430		40.2			No. 2 pug aged 15 days
		519	20.7	39.9			

The "B" clay unlike the "A" clay when treated with acid shows no falling off in strength; indeed, there is some gain though not exceeding likely variations due to differences in pugging, water content, etc. Aging the acid-treated clay shows some increase in strength of the air bars but not much, and none in the vacuum bar.

It seems that electrolytes play other parts than merely flocculation and deflocculation. Their effect on mineral solution and reactions with adsorbed salts are also important factors in their influence upon plasticity and bonding power.

TESTS OF A COAL MEASURE PLASTIC FIRE CLAY

		Modulus	Gain (%)	Water (%)	Shrinkage (%)	Sp. gr.	Treatment
1	Air	354		25.0	6.68	1.939	
	Vacuum	518	46.3	25.3	6.93	2.007	
2	Air	405		25.8	6.7	1.933	
	Vacuum	586	44.7	23.2*	6.55	2.008	
3	Air	426		25.1			Same pug as No. 2 aged 5 hours
	Vacuum	611	43.4	25.6			
4	Air	665		26.9			No. 2 pug aged 5 weeks
	Vacuum	688	3.5	26.7			
5	Air	322		24.4			New sample factory pugmill pugged and aged 8 days
	Vacuum	379	17.7	24.3			

* This low water content probably is due to lack of uniformity in the pug and is not an error in weighing since the shrinkage of the vacuum bar is less than that of the air bar; this is the only instance of such lower shrinkage in the vacuum bars.

(3) Plastic Fire Clay The first three sets are fairly consistent. Numbers 1 and 2 are different pugs of the same sample and No. 3 stood several hours before working it.

Number 4 is a remarkable example of the effect of aging. It was aged longer than any previous tests which should be more effective, but it does not follow that aging should have the same numeral effect on different clays. Whatever consumes the air in the process of aging will differ in its activity in different clays.

Number 5 is a new sample and its weakness may be due to a variation in the clay as happened in the Bedford shale samples, or it may be due to pugmill pugging. The value of wet-pan pugging over pugmill pugging is presented in the Bedford shale tests.

The low percentage gain of the vacuum test of No. 5 is consistent since the clay was aged eight days.

VI. Conclusions

The limited tests above presented are not sufficient to serve as a basis for conclusions upon plasticity and bonding power of clays but there are a few factors which consistently stand out in the tests.

(1) In every test, without exception, the strength of the dry ware which is the basis of the bonding power measurement is increased by de-airing the clay in the process of manufacture.

(2) Without exception the bulk specific gravity of the ware is higher in the de-aired product.

(3) The linear shrinkage of the ware is increased in every case except one noted and which should not be considered.

(4) Aging increases the plasticity and bonding power but in every test of the aged clay the gain in strength in the de-aired bars is less than the gain in freshly pugged clay. This drop is real and not merely apparent. The conclusion that there is less occluded air in the aged clay than freshly pugged clay is justified.

(5) The time of aging seems to be a factor but the tests are too limited to draw a final conclusion in this respect.

(6) De-airing freshly pugged clay is more effective in increasing the bonding strength than aging without subsequent de-airing. Maximum strength comes from de-airing aged clay.

(7) Wet-pan preparation of the clays seems to have advantages over pugmill preparation.

(8) All the clays tested improve by de-airing but not in equal degree.

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VOLUME CHANGES IN BRICK MASONRY MATERIALS[1]

By L. A. Palmer

ABSTRACT

Volume changes in brick and mortars attending variations in moisture content and temperature have been studied. There were included in the study 21 cements (both Portland and masonry), 7 limes, and 8 makes of brick received from various sections of the United States. The shrinkage of mortars during hardening and the alternate expansion on wetting and shrinkage on drying occurring subsequent to hardening have been measured. Varying the moisture content produced far smaller volume changes in well-fired brick than in most of the mortars. Underfired brick expanded appreciably on wetting. It is indicated that differential volume changes between brick and mortar caused by variations in moisture content are apt to be greater than those produced by normal temperature variations. Volume changes in hardened mortars were least in the case of straight lime-sand mortars.

I. Introduction

(1) Purpose and Scope

Absence of differential contraction or expansion among masonry units and mortars should contribute to the durability of masonry. A lack of durability of bond between mortar and masonry units is often noted in masonry that is exposed to moisture. Sabin[2] has stated that a failure in masonry is more likely to occur in adhesion than in cohesion. Pearson[3] has indicated the importance of minimizing the volume changes as causes of cracks in stucco applied over masonry. Schurecht and Pole[4] have studied expansions in ceramic bodies that were exposed freely to moisture. Stradling[5] has interesting data concerning the effect of moisture changes on building materials and has shown that moisture expansions of different materials vary over a wide range.

Exclusive of volume changes in a masonry material produced by compression or tension, there are changes due (1) to temperature and (2) to moisture content. In certain materials the latter is a factor of much greater importance than the former. White[6] reported bars cut from sidewalks twenty years old elongating 0.175% on immersion in water at room

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, (Structural Clay Products Division). Received March 28, 1931.

Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce

[2] L. C. Sabin, Cement and Concrete, 2nd ed., p. 106 (1907).

[3] J. C. Pearson, "Shrinkage of Portland Cement Mortars and Its Importance in Stucco Construction," *Proc. Amer. Concrete Inst.*, **17**, 135 (1921).

[4] H. G. Schurecht and G. R. Pole, "Effect of Water in Expanding Ceramic Bodies of Different Compositions," *Jour. Amer. Ceram. Soc.*, **12** [9], 596–604 (1929).

[5] R. E. Stradling, "Effects of Moisture Changes on Building Materials," Dept. Sci. Ind. Research, *Building Research Bull.*, No. 3.

[6] A. H. White, "Volume Changes in Portland Cement and Concrete," *Proc. A.S.T.M.*, **14**, 203 (1914).

temperature, equivalent to an elongation for a 300°F rise in temperature. Previously White[7] gave 0.02% as the volume change in brick on wetting and drying. Data by Davis and Troxell[8] and other investigators show that volume changes in mortars and concrete due to moisture are more important than the normal thermal changes.

The volume changes occurring in a mortar depend to a great extent on its environment. One cannot therefore predict whether or not the mortar will remain bonded to masonry units. By reducing, however, to the lowest possible minimum the differential volume changes in unit masonry, the life of the bond should be increased. Increasing the life of the bond between mortar and units should help in part at least to reduce water penetration through the masonry.

Water may combine chemically or may be held mechanically by a building material. Sometimes it is said to be adsorbed. Adsorption is a physico-chemical process. Absorption is a strictly physical one. McBain and Ferguson[9] have referred to moisture held in any of the three ways as "sorbed" water and to the process as "sorption." Their data indicate that for the most part well-fired brick merely hold water mechanically, the amount adsorbed or chemically combined being negligible. They found, furthermore, that certain natural as well as cast stones "sorbed" water from humid air and that this is particularly characteristic of concrete and materials containing Portland and natural cements. Results obtained by Washburn[10] indicate that an underfired clay body may hydrate and adsorb water. The curves presented by Stradling[5] indicate that there is relatively more expansion of materials which "sorb" moisture than of those which hold water only mechanically. White[11] concludes that Portland cement is hydrated with each wetting. White[12] also states that hydrated lime will carbonate, forming crystalline $CaCO_3$ which is only slightly affected by moisture.

(2) Materials A fairly clean mortar sand was used in all these tests. On U. S. standard sieves 23% passed No. 20 and was retained on No. 30; 59% passed No. 30 and was retained on No. 50. There were no sand particles of diameter greater than $^1/_8$ inch.

Eleven typical Portland cements were included in the study and one (No. 12) composed of about equal proportions by weight of Portland

[7] A. H. White, "Destruction of Cement Mortars and Concrete through Expansion and Contraction," *Proc. A.S.T.M.*, **11**, 531 (1911).

[8] Raymond E. Davis and G. E. Troxell, "Volumetric Changes in Portland Cement Mortars and Concretes," *Proc. Amer. Concrete Inst.*, **25**, 210–60 (1929).

[9] McBain and Ferguson, *Jour. Phys. Chem.*, **31** [4], 562–94 (1927).

[10] Edward W. Washburn and Frank F. Footitt, *Jour. Amer. Ceram. Soc.*, **4** [12], 974 (1921). See also R. C. Purdy, *Trans. Amer. Ceram. Soc.*, **9**, 213 (1907).

[11] See footnotes 6 and 7.

[12] A. H. White, "Use of Lime in Stuccos," *Proc. Nat. Lime Assn.*, p. 109 (1916).

cement and blast-furnace slag. Two (Nos. 2 and 11) were white Portland cements. One (No. 5) was a fairly quick hardening cement.

Seven limes were studied. Three (Nos. 1, 5, and 6) were high calcium hydrated limes. The others (Nos. 2, 3, 4, and 7) were dolomitic hydrates. Number 6 was quick (lump) lime.

There were nine masonry cements. Number 1 was a mixture of hydrated lime and water-granulated blast-furnace slag. Number 2 was the same as Portland cement No. 11, but contained calcium stearate. Number 3 was a mixture of hydrated lime and Portland cement. Number 4 was a hydraulic lime. Number 5 was a Portland cement with paraffin added to give it water-repellent properties. Numbers 6 and 9 were natural cements. Number 7 was a mixture of Portland cement, crushed limestone, and bentonite, and No. 8 was a mixture of Portland and natural cements.

Table I gives the absorption range for each make of brick used in the process of molding, and the raw materials used in its manufacture.

TABLE I

KINDS OF BRICK USED

Brick No.	Range of total absorption (%) (48 hr. cold immersion)	Molding process	Raw material
1*	11.5–17.5	Dry-press	Mixture of surface clay and shale
2	5.2–10.7	Stiff-mud (side cut)	Shale
3	6.0–11.5	Stiff-mud (side cut)	Shale
4	9.5–16.0	Dry-press	Surface clay
5	4.2– 9.0	Dry-press	Fire clay
6	4.5– 9.8	Stiff-mud (side cut)	Fire clay
7*	18.4–25.1	Dry-press	Surface clay
8*	19.4–25.5	Soft-mud	Surface clay

* Admitted by the manufacturer that the shipment contained underfired brick.

II. Preparation of Specimens

(A) Mortar Specimens

(1) Properties of Dry Ingredients Except in the case of lime No. 6, the amounts of dry ingredients were proportioned on a volume basis. The weights as well as the volumes of each dry ingredient were obtained.

The weights of the high calcium hydrated limes (1 and 5) in the mortars composed of one volume of hydrated lime and three volumes of sand (1:3 mortars) were approximately one-seventh that of the sand in the case of both limes. In case of No. 6, a high calcium quicklime, a 1:3 mortar was made from it by using an amount such that the weight of the CaOH equivalent of the CaO added was one-seventh of the weight of sand.

The linear changes were lowest with 1:3 mortars made with Portland

cement No. 1 and lime No. 6 and highest in such mortars made with cement No. 12 and lime No. 2. Specimens were made with mixtures of these limes and cements. The proportions by volume in the mortar admixtures were 1 lime : 1 cement : 6 sand; 1 lime : 1 cement : 8 sand; and 2 lime : 1 cement : 9 sand.

(2) Mixing Water The amount of water required to produce "standard consistency" was determined in each case by the flow table method described in sections F3g(3)a and F3g(3)b, Federal Specification (revised) SS-C-181 for cement masonry.

(3) Molding Specimens for Initial Shrinkage Specimens 1 by 1 by 10 inches were made in brass frames, accurately machined and about one-half inch longer to allow space for two glass plates, each $^1/_4$ inch in thickness to be cemented to the ends of the specimens. The centers of the plates were marked and measurements were taken between these marks on the plates.

All hydrated limes were soaked in the mixing water in air-tight containers for a period of 48 hours before specimens were molded. The quicklime (lime No. 6) was soaked in this manner for two weeks.

(4) Molding Specimens for Volume Changes Subsequent to Hardening These were made in steel frames (5 by 23 by 1 inch) resting on glass plates covered with waxed paper. In this case there were two $^3/_4$- by $^3/_4$- by $^1/_4$-inch glass plates cemented into each end of the specimens near the corners to afford smooth contact points for extensometer readings.

After filling the frames with mortar, two $^1/_4$-inch glass rods covered with waxed paper were stuck perpendicularly through the 1-inch thick slab of fresh mortar, 20 inches apart, and centered $1^1/_2$ inches from the end of the specimen.

When the mortar had hardened sufficiently the glass rods were removed and brass screws having countersunk holes were inserted and cemented firmly in place with litharge-glycerine cement. The screws were turned to positions such that the points of the strain gage fitted nicely the holes in the screw heads.

Six specimens of each were made during the course of a week, each one being made on a different day.

The total number of specimens of all mortars was 540. There were 45 mortars and these are listed in Table II.

(B) Brick Specimens

Twenty-four brick from each of the 8 makes of brick, 12 of the hardest, and 12 of the softest fired brick of each shipment were selected by visual inspection. Since the possible expansion on wetting and contraction on drying of these brick was to be determined, their selection could not be

made by absorption. Absorption was, however, determined with other soft- and hard-fired brick (of each shipment) similar to those selected. (See Table I.)

Three brick were used to form a specimen. They were first dried at 150°C to constant weight (little moisture was found to be present). The ends of the brick were roughened and joined together with a paste of litharge-glycerine cement and squeezed tightly together by bench

TABLE II

MORTARS

Cementing materials	Proportions by volume	No. of test specimens
Limes, 1 to 7	1 L.:3 S	84
Portland cements, 1 to 12*	1 P. C.:3 S	144
Masonry cements, 1 to 9	1 M. C.:3 S	108
Lime No. 2	1 L.:4 S	12
Lime No. 6	1 L.:4 S.	12
Portland cement No. 1	1 P. C.:4 S.	12
Portland cement No. 12*	1 P. C.:4 S	12
Masonry cement No. 1	1 M. C.:4 S	12
Masonry cement No. 2	1 M. C.:4 S	12
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:6 S	12
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S	12
Lime No. 6 and Portland cement No. 1	2 L.:1 P. C.:9 S	12
Lime No. 2 and Portland cement No. 12*	1 L.:1 P. C.:6 S	12
Lime No. 2 and Portland cement No. 12*	1 L.:1 P. C.:8 S	12
Lime No. 2 and Portland cement No. 12*	2 L.:1 P. C.:9 S	12
Portland cement No. 1	1 P. C.:3 S and calcium stearate**	12
Portland cement No. 1	1 P. C.:4 S and calcium stearate**	12
Portland cement No. 12*	1 P. C.:3 S and calcium stearate**	12
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:6 S and calcium stearate**	12
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S and calcium stearate**	12

* Portland cement and blast-furnace slag mixture.

** The amount of dry calcium stearate added was 2% of the weight of cement or of the combined weights of lime and cement when both were used.

clamps. The combined thickness of the two joints in a specimen of 3 brick was about $^1/_8$ inch. Any shrinkage or expansion in the cementing material could therefore introduce only a small error. Holes were drilled in each specimen 20 inches apart. Screws with heads drilled and countersunk were cemented into these holes with the litharge cement.

In Fig. 1, *a* is a brick specimen, *b*, a 1- by 5- by 23-inch mortar specimen, *c*, the standard Invar steel bar for reference, and *d*, the 20-inch Whittemore type strain gage with Invar side bars.

III. Exposure of Test Specimens

(1) Mortar Specimens for Shrinkage during Hardening

The 1- by 1- by 10-inch specimens were removed as soon as made to a room wherein the relative humidity was 60±5% and the temperature was 21±1°C. They remained here

for a period of 10 days. The lengths of the specimens were measured at the end of 48 hours and 10 days.

(2) Mortar Specimens for Linear Changes Subsequent to Hardening

Test specimens containing cement (*i.e.*, either straight Portland or masonry cement mortars or admixtures of lime and Portland cement) were stored under water when 48 hours old. They remained so immersed for 3 months. The water was changed frequently.

After three months in water, the specimens were removed and stood on edge on the laboratory table in front of a continually operating electric fan. At least three days were required to remove the bulk of the water. The specimens were then placed flat side down on dry sand in metal trays. The trays and specimens were placed in a drying oven, the temperature of which was maintained at nearly 38°C and seldom varied more than $^1/_2$°C. A metal tray containing granulated calcium chloride was placed in the bottom of the oven. An electric fan within the oven served to keep the humidity uniform throughout the oven. Usually the relative humidity ranged from 20 to 25%.

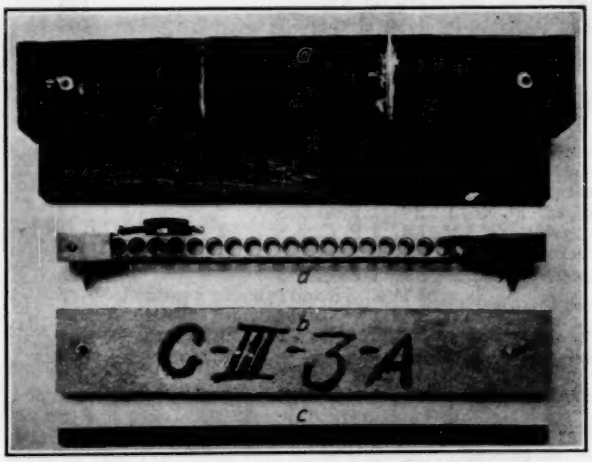

FIG. 1. Materials and equipment used in the study of volume changes in brick masonry: (*a*) brick specimen; (*b*) mortar specimen; (*c*) Invar steel bar; (*d*) strain gage.

The specimens were removed from the oven when, during a weeks' interval, there was no change in length of a specimen greater than 0.0004 inch.

They were returned to the laboratory and put in water where they were kept for another 3 months. The specimens were then removed and again dried to "constant length" in the oven and returned again to water.

The specimens (1 by 5 by 23 inches) containing lime and sand alone were quite fragile during the first week or 10 days after they were formed. For this reason no attempt was made to handle them during the first 10 days. At the end of this time, the brass screws for strain-gage readings

were fastened in the specimens and the latter then remained for three months exposed only to the air of the laboratory wherein they were made. It was found convenient to keep these specimens on glass plates, $^1/_4$ of an inch thick, during all tests.

A record of the daily temperatures and relative humidity of the laboratory was kept. The average relative humidity of the laboratory during a year was between 35 and 50% and varied from a minimum of 18% to a maximum of 80%. The temperature varied from 15 to 32°C, the average being about 19°C. These were therefore typical drying conditions.

After three months storage in the laboratory, the lime-mortar specimens were taken to a room wherein the relative humidity was approximately 95% and the temperature was 21°C (± 1°C). Here the specimens remained for another period of 3 months and once daily during this time they were thoroughly sprinkled.

Following this procedure, the specimens were dried first in the air of the laboratory, using fan circulation. When the bulk of moisture was removed, the specimens were dried at 38°C in the constant temperature oven until the change in length was not greater than 0.0004 inch per week.

After drying, the specimens (on glass plates) were placed in metal trays and kept about half submerged in water. Complete immersion was impracticable for in this case the specimens became soft. Care was taken to keep the water level fairly constant. Water rose by capillarity and kept the lime-mortar specimens saturated. At the same time, the hardening process could take place to some extent at least. After soaking in this manner for 3 months the specimens were again dried to "constant length."

(3) Changes in Length Due to Thermal Change After one of the oven dryings three of the six specimens were left for one day in the laboratory. Then the room-temperature and strain-gage readings of the specimens were recorded and were taken to a freezing room. The temperature of the freezing room ranged from −12 to −5°C. The specimens remained here for at least twelve hours and strain-gage readings were again taken. If the data for each of the three specimens were not in fairly good agreement, the entire procedure was repeated until results checked reasonably well. The temperature difference between the laboratory and the freezing room was about 25 to 40°C.

(4) Brick Wetting and Drying The dry brick specimens were first measured with the strain gage in the laboratory and were then immersed in water maintained at room temperature. After a month they were removed from water and strain-gage readings were again taken. The specimens were dried for a week at 150°C, cooled to room temperature, and again measured. This procedure was then once more repeated.

(5) Brick Freezing and Thawing

The dry brick specimens were immersed for 48 hours in water at room temperature, removed at the end of that time to the freezing chamber where they remained 18 hours and were thawed under water at room temperature for 6 hours. They were then again frozen and thawed. If no signs of disintegration were in evidence, the process was continued until the specimens had endured from 18 to 20 cycles of freezing and thawing. After freezing and thawing, the specimens were dried at 150°C for a period of one week. Strain-gage readings were taken before putting the dry specimens in water, after 48 hours soaking, during each time they were frozen, after each thawing, and after cooling when removed from the oven.

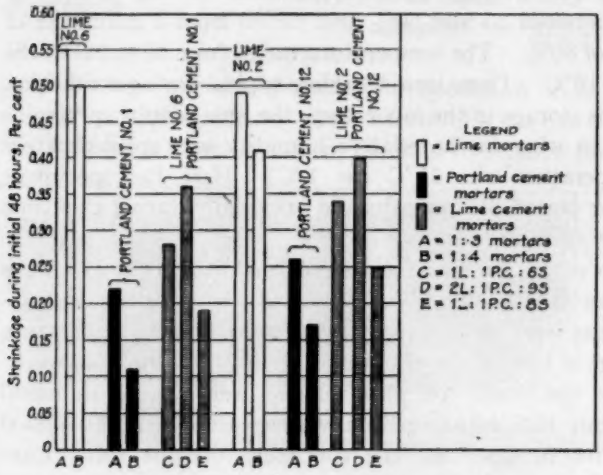

FIG. 2.—Shrinkage of mortars during early hardening.

(6) Thermal Change in Brick

The specimens were kept dry throughout these tests. They were removed from the laboratory to the freezing room where they remained for at least 12 hours. They were then returned to the laboratory and the cycle was repeated several times. The laboratory and freezing room temperatures were recorded at the time strain-gage readings were taken.

IV. Results

(1) Initial Shrinkage of Mortars

The initial shrinkages of various mortars are shown in Fig. 2. These data include values obtained at the end of 48 hours. Shrinkage is expressed in terms of per cent of changes in length.

(2) Effect of a Water-Repellent Substance on Initial Shrinkage

The effect on initial shrinkage produced by adding water-repellent substances was not studied extensively. This effect has been investigated by others[13] and their results have indicated that no material decrease in the extent of initial shrinkage or of

[13] See footnote 8.

either shrinkage or expansion subsequent to hardening is effected through the use of such substances.

Portland cement No. 11 contained no water-repellent substance. Masonry cement No. 2 contained calcium stearate added by the manufacturer. These two materials were made at the same plant. Table III gives the initial shrinkages of mortars with and without calcium stearate.

With the exception of Portland cement No. 1 (1P. C. : 4 sand) the differences seen in Table III are not significant and no effect of the calcium stearate was detected.

TABLE III

SHRINKAGES OF MORTARS WITH AND WITHOUT CALCIUM STEARATE DURING INITIAL 48 HOURS

(Values are averages for 6 specimens)

Cementing material	Mortar (proportions by vol.)	Decrease in initial length (%)	
		With calcium stearate	Without calcium stearate
Portland cement No. 11	1 P. C.:3 S		0.19
Masonry cement No. 2*	1 M. C.:3 S	0.20	
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:6 S	0.32	0.28
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S	0.18	0.19
Portland cement No. 1	1 P. C.:4 S	0.18	0.11
Portland cement No. 1	1 P. C.:3 S	0.24	0.22
Portland cement No. 12**	1 P. C.:3 S	0.27	0.26

* The amount of calcium stearate present in masonry cement No. 2 was not definitely known. In all other mortars of Table III, the calcium stearate was 2% of the total weights of cementing materials.

** Mixture of Portland cement and blast-furnace slag.

(3) Effect of Thermal Change The linear changes obtained by subjecting dry mortar specimens to changes in temperature are given in Table IV. The variation in thermal coefficients of expansion among the 1:3 mortars was not as great as might have been expected. A possible reason for this may be the preponderance of sand. The coefficients of the Portland cement 1:3 mortars were generally slightly higher than those of 1:3 mortars made with the limes and masonry cements. This may have been due to the fact that the weight of cementing material is usually relatively greater in a 1:3 Portland cement-sand mortar.

The alternate shrinkages on drying and expansions on wetting the cement mortars are shown in Table V. They are comparable to data obtained by others. It is interesting to note that the general tendency of the lime mortars was to expand even under drying conditions in some instances. Thus there was no shrinkage whatever in lime No. 1 mortar. During the entire period of test (approximately one year) lime No. 1 specimens expanded 0.042%. The net volume change obtained with mortar specimens made from lime No. 6 was an expansion of 0.005%.

TABLE IV

LINEAR THERMAL COEFFICIENTS OF EXPANSION OF MORTARS

Coefficient $C = \frac{\Delta L}{L \Delta t}$, where ΔL is the change in length per 20 inches (L) during a temperature change of Δt°C

(Values are averages for 3 specimens)

Cementing material Portland cement No.	Mortar	ΔL (inches)	Δt (°C)	$\epsilon \times 10^6$
1	1 P. C.:4 S	0.0042	33.4	0.63
1	1 P. C.:3 S	0.0067	36.0	0.93
2	1 P. C.:3 S	0.0068	39.5	0.82
3	1 P. C.:3 S	0.0073	39.5	0.95
4	1 P. C.:3 S	0.0084	38.3	1.11
5	1 P. C.:3 S	0.0085	39.0	1.09
6	1 P. C.:3 S	0.0087	40.0	1.09
7	1 P. C.:3 S	0.0050	34.0	0.76
8	1 P. C.:3 S	0.0071	36.0	0.98
9	1 P. C.:3 S	0.0083	38.3	1.08
10	1 P. C.:3 S	0.0073	41.8	0.87
11	1 P. C.:3 S	0.0060	32.3	0.93
12*	1 P. C.:3 S	0.0069	33.0	1.06
12*	1 P. C.:4 S	0.0043	36.1	0.60
Masonry cement No.				
1	1 M. C.:3 S	0.0066	41.0	0.80
2	1 M. C.:3 S	0.0077	41.0	0.94
3	1 M. C.:3 S	0.0060	33.3	0.90
4	1 M. C.:3 S	0.0055	34.3	0.85
5	1 M. C.:3 S	0.0068	36.0	0.94
6	1 M. C.:3 S	0.0059	35.8	0.82
7	1 M. C.:3 S	0.0049	35.8	0.68
8	1 M. C.:3 S	0.0065	38.9	0.83
9	1 M. C.:3 S	0.0070	33.4	1.08
1	1 M. C.:4 S	0.0057	41.0	0.70
2	1 M. C.:4 S	0.0048	36.0	0.66
Lime No.				
1	1 L.:3 S	0.0056	29.4	0.95
2	1 L.:3 S	0.0050	31.1	0.81
3	1 L.:3 S	0.0050	34.0	0.76
4	1 L.:3 S	0.0056	35.5	0.80
5	1 L.:3 S	0.0068	38.3	0.89
6	1 L.:3 S	0.0061	41.0	0.74
7	1 L.:3 S	0.0060	33.5	0.84
6	1 L.:4 S	0.0055	41.0	0.67
2	1 L.:4 S	0.0049	35.5	0.69
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:6 S	0.0063	37.8	0.83
Lime No. 2 and Portland cement No. 12*	1 L.:1 P. C.:6 S	0.0041	26.4	0.78
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S	0.0048	28.0	0.86
Lime No. 2 and Portland cement No. 12*	1 L.:1 P. C.:8 S	0.0051	30.0	0.83
Lime No. 6 and Portland cement No. 1	2 L.:1 P. C.:9 S	0.0056	31.1	0.90
Lime No. 2 and Portland cement No. 12*	2 L.:1 P. C.:9 S	0.0048	30.0	0.80

* Mixture of Portland cement and blast-furnace slag.

This was less than one-tenth of the expansion of the various Portland cement mortars during 3 months immersion in water.

The expansion of the Portland and masonry cement mortars during

TABLE V

LINEAR CHANGES IN 1:3 HARDENED MORTAR SPECIMENS SUBJECTED TO ALTERNATE WETTING AND DRYING

(+ denotes expansion; − denotes shrinkage; values are averages of results obtained with 6 specimens)

1:3 Portland and masonry cement mortars

Cementing Material	Average per cent change in length of specimens during each exposure (Tests begun when specimens were 48 hours old)					
	3 months in water	Dried to "constant length"	3 months in water	Dried to "constant length"	Third soaking period	
Portland cement No.	(%)	(%)	(%)	(%)	Months	(%)
1	+0.005	−0.079	+0.059	−0.057	5	+0.066
2	+0.014	−0.088	+0.063	−0.062	5	+0.068
3	+0.028	−0.080	+0.059	−0.056	5	+0.058
4	+0.006	−0.087	+0.064	−0.064	5	+0.065
5	+0.016	−0.094	+0.063	−0.054	5	+0.059
6	+0.009	−0.095	+0.062	−0.051	5	+0.055
7	+0.012	−0.082	+0.054	−0.047	3	+0.052
8	+0.017	−0.090	+0.057	−0.055	3	+0.059
9	+0.028	−0.084	+0.061	−0.058	3	+0.055
10	+0.023	−0.095	+0.064	−0.060	3	+0.058
11	+0.028	−0.101	+0.070	−0.066	3	+0.073
12**	+0.029	−0.164	+0.082	−0.077	3	+0.074
Masonry cement No.						
1	+0.020	−0.055	+0.046	−0.051	6	+0.051
2	+0.025	−0.108	+0.064	−0.060	6	+0.073
3	+0.043	−0.085	+0.070	−0.050	4	+0.059
4	+0.030	−0.085	+0.058	−0.046	4	+0.049
5	+0.015	−0.082	+0.065	−0.054	4	+0.058
6	+0.040	−0.076	+0.054	−0.048	4	+0.043
7	+0.003	−0.065	+0.038	−0.041	4	+0.046
8	+0.006	−0.074	+0.045	−0.042	4	+0.042
9	+0.031	−0.054	+0.041	−0.034	4	+0.036

1:3 Lime Mortars

Cementing Material	Average per cent change in length of specimens during each exposure (Tests begun when specimens were 10 days old)				
Lime No.	3 months in air (laboratory) (%)	3 months in humid room, sprayed daily (%)	Dried to "constant length" (%)	3 months partially immersed in water (%)	Dried to "constant length" (%)
1	+0.008	+0.027	+0.004	+0.003	No change
2	+0.002	+0.071	−0.004	+0.019	+0.004
3	+0.008	+0.021	−0.017	+0.011	+0.006
4	+0.003	+0.036	−0.002	+0.003	−0.002
5	+0.004	+0.014	−0.004	+0.002	−0.004
6	No change	+0.008	−0.001*	+0.002	−0.004
7	−0.004	+0.022	−0.007	+0.001*	+0.003

* Mixture of Portland cement and blast-furnace slag.
** About the magnitude of the probable error in measurement.

the first 24 hours soaking (following a drying period) varied from 0.02 to 0.05%. The rate of expansion of the lime mortars was very much less than this. The comparative rates and magnitude of changes in length

of 1:3 mortar specimens made from lime Nos. 2 and 6 and Portland cement Nos. 1 and 12 may be noted in Fig. 3. The full lines in each curve denote linear changes during wetting and the broken lines denote such changes during the drying periods. The origin is the average of the readings of the 6 specimens of each mortar taken at the beginning of the second exposure (column 3, Table V); that is, the specimens at this point (the origin) were 3 months old. The 1:3 lime mortars were kept saturated during the second exposure whereas the 1:3 Portland cement mortars were dried to "constant length." The drying procedure was not con-

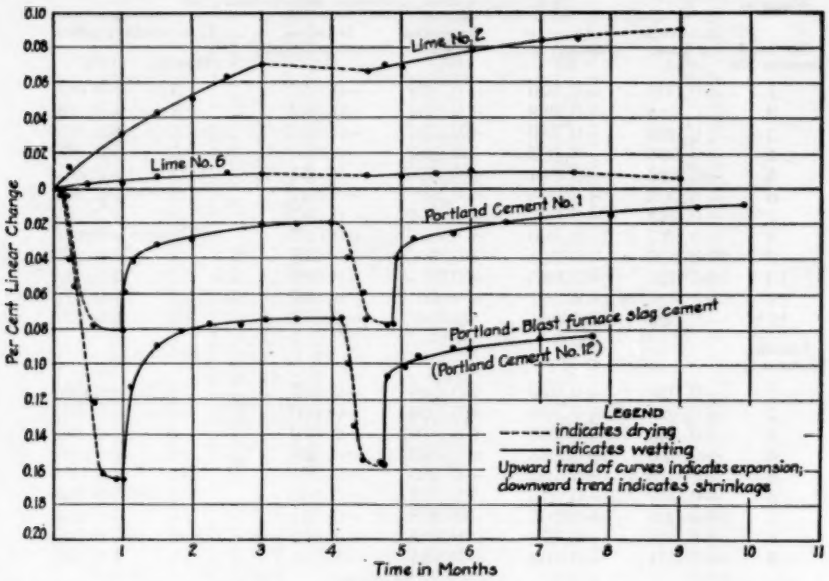

FIG. 3.—Volume changes in cement and lime mortars as determined with 3 months' old specimens.

tinued over any definite period of time. Drying was discontinued when during a period of one week the linear change in a specimen did not exceed 0.0004 inch per 20 inches.

Linear changes produced by alternately wetting and drying the 1:4 mortars are presented in Table VI. A comparison of the data in this table with the data in Table V for the same cementing materials (considering only those linear changes of greatest magnitude for these materials) indicates that with the possible exception of lime No. 6, the shrinkage on drying and expansion on wetting was less generally in the 1:4 than in the 1:3 mortars. The difference, although appreciable, hardly warrants a preference of the 1:4 mortars from this standpoint alone. The mason usually experiences more difficulty in troweling the leaner mixes and this

fact must also be considered. The linear expansion and shrinkage both in 1:3 and 1:4 mortars made with lime No. 6 were relatively small. The fact that the linear changes were slightly higher in the latter case may not therefore be significant.

Curve A of Fig. 4 is obtained by plotting the data of Pearson.[3] The small portions of curves B and C are obtained by plotting the data relative to Portland cements 1 and 12 of the third column, Tables V and VI. The curve obtained by plotting Pearson's data indicates a sharp decrease in the effect of leanness on linear shrinkage above the point designating 1:1 mortar.

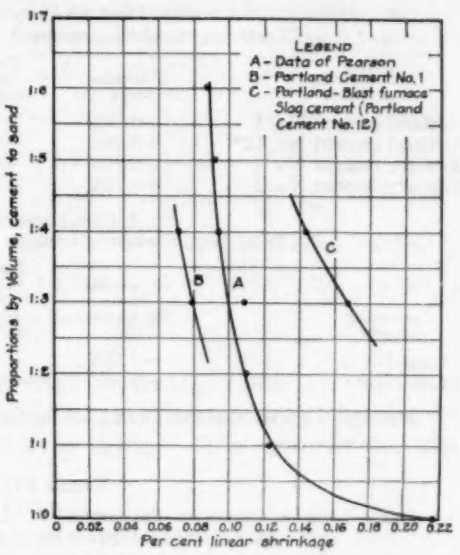

FIG. 4.—The effect on linear shrinkage produced by varying the proportions (by volume) of cement and sand.

The per cent linear changes produced by varying the moisture content of the mortars are given in Table VII. The data here indicate that generally a reduction in shrinkage and expansion was effected by having a lime content higher than that in a 1L:1P.C.:6S mortar. The 1L:1P.C.:8S may be considered as a 1:4 and the 1L:1P.C.:6S as 1:3 mortar, and a comparison of the data for these two mortar admixtures shows what was effected by increasing the relative proportion of sand. The average linear shrinkage during the first drying (column 5, Table VII) of the 1:1:6 mortar specimens made with lime No. 6 and Portland cement No. 1 was greater (Table V, column 3) than that of the 1:3 Portland cement No. 1 mortar specimens. From the data of Tables V and VII, it is seen that the reverse was true in the case of lime No. 2 and the Portland blast-furnace slag cement (Portland cement No. 12).

It may also be observed that the expansions on wetting (column 6, Table VII) and shrinkages on drying (last column of Table VII) of the 1:1:6 and 2:1:9 mortars subsequent to the first drying, were smaller in all cases than the linear changes attending such exposures of the 1:3 cement mortars (fourth and fifth columns, Table V). The rate of initial shrinkage of the lime-cement mortars may possibly have been less than that of the cement (no lime) mortars. If this is true, the shrinkage was probably

more nearly completed at the end of 48 hours in the cement mortars than it was in the cement-lime mortars. Then during a later period when conditions were favorable, the shrinkage of the latter would be greater than that of the former, which was the case.

TABLE VI

PER CENT LINEAR CHANGES PRODUCED BY ALTERNATELY WETTING AND DRYING 1:4 MORTARS SUBSEQUENT TO HARDENING

(Averages of 6 specimens; + denotes expansion; − denotes shrinkage)

1:4 Portland and masonry cement mortars
(Tests begun when specimens were 48 hours old)

Cementing material	3 months in water (%)	Dried to "constant length" (%)	3 months in water (%)	Dried to "constant length" (%)
Portland cement No. 1	+0.009	−0.071	+0.042	−0.040
Portland cement No. 12*	+0.007	−0.145	+0.080	−0.078
Masonry cement No. 1	+0.024	−0.035	+0.026	−0.021
Masonry cement No. 2	+0.012	−0.090	+0.051	−0.047

1:4 lime mortars
(Tests begun when specimens were 10 days old)

Cementing material	3 months in air (laboratory) (%)	3 months in humid room (sprayed daily) (%)	Dried to "constant length" (%)	Partially immersed in water for 2 months (%)
Lime No. 2	−0.002	+0.040	−0.005	+0.019
Lime No. 6	−0.010	+0.011	−0.002	No change

* Mixture of Portland cement and blast-furnace slag.

TABLE VII

PER CENT LINEAR CHANGES PRODUCED BY ALTERNATELY WETTING AND DRYING MORTARS MADE FROM BOTH LIME AND CEMENT

Tests begun when specimens were 48 hours old (average values for 6 specimens; + denotes expansion; − denotes shrinkage)

Lime No.	Portland cement No.	Proportions by volume	3 months in water (%)	Dried to "constant length" (%)	3 months in water (%)	Dried to "constant length" (%)
6	1	1 L.:1 P. C.:6 S	+0.007	−0.111	+0.050	−0.043
6	1	2 L.:1 P. C.:9 S	+0.018	−0.069	+0.042	−0.032
2	12*	1 L.:1 P. C.:6 S	+0.015	−0.126	+0.049	−0.046
2	12*	2 L.:1 P. C.:9 S	+0.013	−0.072	+0.034	−0.031
6	1	1 L.:1 P. C.:8 S	+0.008	−0.068	+0.042	−0.041
2	12*	1 L.:1 P. C.:8 S	+0.007	−0.085	+0.045	−0.037

* Mixture of Portland cement and blast-furnace slag.

The mortars to which calcium stearate was added in the laboratory together with 1:3 mortars made with masonry cement No. 2 did not undergo any greater or less degree of volume change during wetting and drying than did the same mortars without the stearate. It was indicated, however, that the *rate* of shrinkage on drying and expansion on wetting was to some extent diminished by the presence of calcium stearate. If the data of Table VIII are compared with those of Tables V, VI, and VII,

it will be observed that the magnitude of the linear changes with calcium stearate (Table VIII) are comparable with those of the same mortars without this water-repellent substance.

TABLE VIII

PER CENT LINEAR CHANGES PRODUCED BY ALTERNATELY WETTING AND DRYING MORTARS CONTAINING CALCIUM STEARATE

Amount of such being 2% of total weight of cementing materials (tests begun when specimens were 48 hours old)

(Average values for 6 specimens; + denotes expansion; − denotes shrinkage)

Cementing materials	Proportions by volume	3 months in water (%)	Dried to "constant length" (%)	3 months in water (%)	Dried to "constant length" (%)
Portland cement No. 1	1 P. C.:3 S	+0.012	−0.081	+0.054	−0.053
Portland cement No. 12*	1 C:3 S	+0.024	−0.166	+0.084	−0.072
Portland cement No. 1	1 P. C.:4 S	+0.007	−0.074	+0.041	−0.045
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:6 S	+0.010	−0.116	+0.053	−0.040
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S	+0.006	−0.065	+0.040	−0.048

* Mixture of Portland cement and blast-furnace slag.

In Table IX are given the average percentage linear expansions of certain mortars with and without calcium stearate during the first 24 hours in water following the first oven drying. It is apparent that the

TABLE IX

PERCENTAGE LINEAR EXPANSION DURING THE FIRST 24 HOURS IN WATER FOLLOWING THE FIRST OVEN DRYING AND WHEN SPECIMENS WERE APPROXIMATELY 4 MONTHS OLD

(Average values for 6 specimens)

Cementing materials	Proportions by volume	Linear expansion	
		With calcium stearate (%)	Without calcium stearate (%)
Portland cement No. 1	1 P. C.:3 S	0.006	0.019
Portland cement No. 12*	1 C.:3 S	0.024	0.043
Portland cement No. 1	1 P. C.:4 S	0.009	0.014
Lime No. 6 and Portland cement No. 1	1 L. 1 P. C.:6 S	0.018	0.022
Lime No. 6 and Portland cement No. 1	1 L.:1 P. C.:8 S	0.006	0.013

* Mixture of Portland cement and blast-furnace slag.

rate of expansion during the first 24 hours in water (following the first drying procedure) was diminished by incorporating calcium stearate in these mortars.

Figure 5 illustrates the comparative rates of shrinkage of 1:3 mortar specimens with and without calcium stearate. The curve for the mortar containing this chemical was obtained by plotting the average linear shrinkages from day to day of the six 1:3 specimens made with masonry

cement No. 2. The other curve is descriptive of the average rate of shrinkage of the six 1:3 specimens made with Portland cement No. 11. The data plotted in Fig. 5 were obtained from strain gage readings taken when the specimens of both mortars were being dried simultaneously at 38°C in the oven. All of these specimens of both mortars had been dried simultaneously for four days in the laboratory prior to putting them in the oven. The "zero" mark in the ordinate scale is with reference to the readings taken on the last day in water preceding drying. During the four days drying in the laboratory there was a very small amount of shrinkage in all of the specimens. The rate of shrinkage was most rapid when the bulk of the water was removed. According to curves presented by Allan[14] the rate of shrinkage in concrete units does not become very noticeable until from 70 to 80% of the moisture is lost.

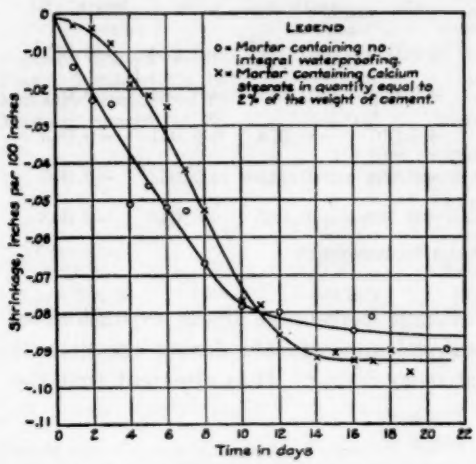

FIG. 5.—Comparative rates of shrinkage of two mortars, one containing calcium stearate and the other containing no water-repellent material whatsoever.

It is indicated from the plotted data of Fig. 5 and the tabulated data of Table IX that the rate at which linear change occurs may be diminished by the presence of calcium stearate. Upon continued wetting or drying, however, the presence of the stearate had no noticeable effect on the final values obtained. In fact the expansion of the mortars after one week in water was about the same with as without the calcium stearate.

(4) Volume Changes in Brick Due to Thermal Change

The term "soft" has but little meaning when applied to materials such as brick Nos. 2, 3, 4, 5, and 6 of Table I. It is noted that the absorption ranges were limited in these cases. Also, strictly speaking, there were no individual brick among the other numbers (1, 7, and 8) which could have been properly called hard fired. Among each make of brick, some samples were harder fired than others. The terms "hard" and "soft fired" in this connection are merely relative.

The linear thermal coefficients of the relatively hard- and soft-fired

[14] W. D. M. Allan, "Shrinkage Measurements of Concrete Masonry," *Proc. Amer. Concrete Inst.*, **26** [6], 699 (1930).

brick of each of the eight types are given in Table X. The lowest coefficient in this table is 0.36×10^{-5} and the highest is 0.85×10^{-5} per degree C. The lowest values were obtained with brick Nos. 5 and 6, both made from fire clay. The highest thermal coefficients were had by brick Nos.

TABLE X

LINEAR THERMAL COEFFICIENTS OF EXPANSION OF BRICK

Coefficient, $C = \frac{\Delta L}{L \Delta t}$, where ΔL is the change in length for 20 inches (L) during a temperature change, Δt°C (values are averages for 2 specimens of 3 brick each)

Brick No.	Soft or hard fired	ΔL (inches)	Δt (°C)	$C \times 10^{-5}$
1	Hard	0.0028	36.5	0.39
	Soft	0.0034	36.5	0.47
2	Hard	0.0032	31.0	0.52
	Soft	0.0031	31.0	0.52
3	Hard	0.0030	36.7	0.41
	Soft	0.0036	36.7	0.49
4	Hard	0.0032	34.0	0.47
	Soft	0.0034	34.0	0.50
5	Hard	0.0025	33.9	0.37
	Soft	0.0026	33.9	0.38
6	Hard	0.0024	33.9	0.36
	Soft	0.0026	33.9	0.38
7	Hard	0.0050	36.5	0.68
	Soft	0.0062	36.5	0.85
8	Hard	0.0040	28.3	0.71
	Soft	0.0041	28.3	0.72

7 and 8, the most porous of all of the eight types of brick. With the exception of brick Nos. 7 and 8, the linear thermal coefficients of the eight makes of brick were distinctly lower than those of the 1:3 mortars given in Table IV.

The average linear thermal expansion of 1:3 mortar made with masonry cement No. 5 (Table IV) was 0.0068 inch per 20 inches per 36°C. Brick No. 1 (hard fired) expanded 0.0028 inch per 20 inches over approximately this same temperature range. The differential expansion between these two materials is computed as 0.0040 inch per 20 inches, or 0.02 inch per 100 inches per 36°C.

(5) Alternate Wetting and Drying Brick

Very few of the brick specimens expanded noticeably when immersed for a month in water. In the absence of such expansion there was of course no shrinkage on subsequent drying. The specimens that did expand noticeably did not shrink to any noticeable extent when dried at 150°C for a week. These data are given in Table XI. Apparently the relatively small expansions were produced by chemical hydration and this chemically-combined water would probably be held permanently by these brick under normal climatic conditions. Whether or not the material would return to its initial dry length by heating at a higher temperature is not a matter of interest in this study. Such moisture expansion, when it did occur,

TABLE XI
PER CENT LINEAR EXPANSION PRODUCED BY WETTING BRICK SPECIMENS

Brick No.	Soft or hard fired	48 hours' immersion in water (expansion) (%)	1 month immersion in water (expansion) (%)
1	Hard	No change in length	0.003*
	Soft	0.002	0.013*
2	Hard	No linear change	No linear change
	Soft	No linear change	No linear change
3	Hard	No linear change	No linear change
	Soft	No linear change	0.005*
4	Hard	No linear change	No linear change
	Soft	+0.003	0.008*
5	Hard	No linear change	No linear change
	Soft	No linear change	No linear change
6	Hard	No linear change	0.003*
	Soft	0.004	0.010*
7	Hard	0.005	0.020*
	Soft	0.016	0.025*
8	Hard	No linear change	0.006*
	Soft	0.006	0.015*

* No shrinkage on drying at 150°C for a week.

was usually noticeable at the end of 48 hours' immersion of the specimens. Holscher[15] reports similar expansion in clay bodies during autoclave treatment.

The maximum linear expansion during a month in water was 0.025%

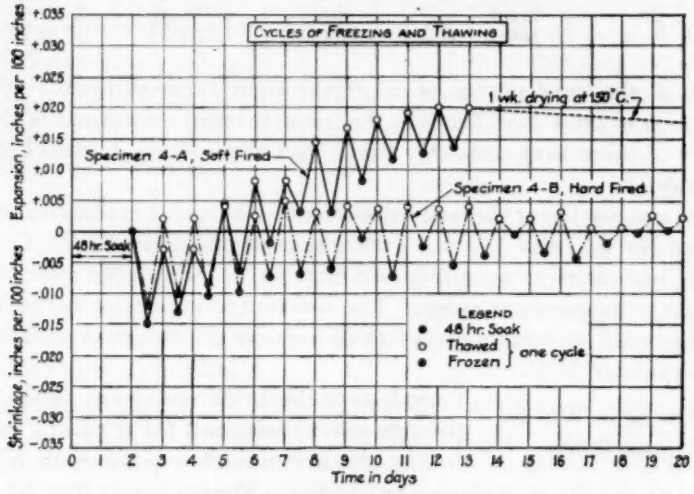

FIG. 6—Linear changes in hard- and soft-fired brick of one make during freezing and thawing cycles.

and this happened in the case of brick No. 7. The maximum linear expansion during 48 hours was 0.016%, about one-fifth of that occurring in some of the 1:3 cement mortars.

[15] H. H. Holscher, "Effects of Autoclave Treatments on Ceramic Bodies and Clays," *Jour. Amer. Ceram. Soc.*, **14** [3], 207–18 (1931).

(6) Alternate Freezing and Thawing of Water-Saturated Brick Specimens

When brick are kept well saturated during freezing and thawing tests, the apparent porosity tends to increase a small amount.[16] There is a progressive increase in the extent of saturation of the brick under these conditions. After many cycles of freezing and thawing, brick contain very nearly as much water as they normally contain when kept in boiling water for 5 hours. It is reasonable to suppose that when there is but little pore space not filled with water, the pressure produced by the water changing to ice tends to increase the size of the pores. Evidently this small distension is permanent under all normal climatic conditions.

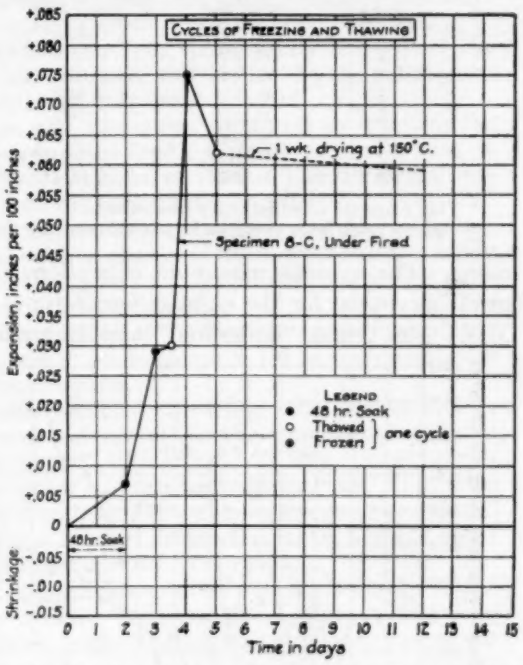

Fig. 7.—Linear expansion of distinctly underfired brick subjected (while saturated) to alternate freezing and thawing.

This slight increase in apparent porosity during progressive freezing and thawing is in some cases attended by a small and relatively slow (usually) expansion of the brick. This is illustrated in Fig. 6. If the brick are not fired to the proper maturing temperature, the expansion (as well as disintegration) is rapid. The softer fired brick of type 8 (8-C, Fig. 7) began to disintegrate after the first two cycles.

The graphs, Figs. 6, 7, and 8, represent all of the extreme and intermediate conditions that were obtained. The specimens containing the harder brick of type 8 were similar in their behavior during freezing and thawing to the specimens of soft-fired brick of type 7, shown in Fig. 8. The graphs of the plotted data (not given) obtained with specimens of both hard- and soft-fired brick of types 2, 3, 5, and 6 and with hard-fired brick of type 1 are similar to 4-B, hard-fired brick of type 4, Fig. 6.

[16] L. A. Palmer and J. V. Hall, "Some Results of Freezing and Thawing Tests Made with Clay and Shale Brick," *Proc. A.S.T.M.*, **30**, 767 (1930).

The plotted data, Figs. 6, 7, and 8, are for individual specimens. The data obtained with the "twin" specimens were so very similar in all cases that each of these graphs could well represent averages for the two speci-

TABLE XII
PER CENT LINEAR EXPANSION OF BRICK SPECIMENS AFTER FREEZING AND THAWING
(Values are averages for two specimens)

Brick	Linear expansion (%)		Number of freezing and thawing cycles	
	Hard fired	Soft fired	Hard fired	Soft fired
1	0.013	0.025**	18	9
2	0.008	0.008	18	18
3	0.002	0.006	18	18
4	0.003	0.022	18	11
5	0.005	0.007	19	20
6	0.006	0.010	20	20
7	0.012	0.029**	18	10
8	0.030	0.074*	5	2

* This material was distinctly underfired.
** These brick were designated as "salmon" by the manufacturer.

mens. The average maximum expansions of both hard- and soft-fired brick specimens for the eight different types of brick are given in Table XII. The terms, "underfired" and "salmon" as applied to these brick

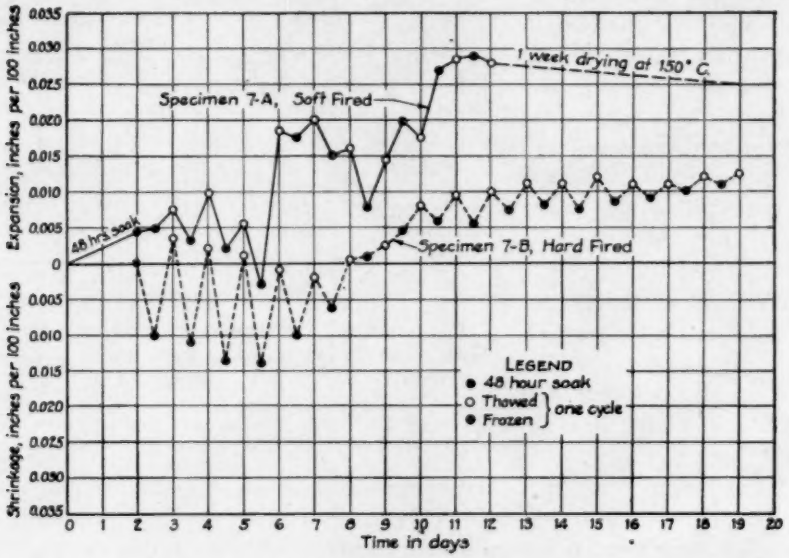

FIG. 8.—Linear changes in hard- and soft-fired brick of one make during freezing and thawing cycles.

are those used by the manufacturer. They were admittedly unfit for facing purposes and were "draw trials" submitted for experimental tests. It is seen from Table XII that the freezing and thawing of the saturated specimens of hard-fired brick produced relatively small linear expansions.

The per cent total absorption by 48 hours cold immersion was actually greater in the hard- than it was in the soft-fired brick of types 1, 7, and 8. The reverse was true in the case of brick of the other types.

V. Summary and Conclusions

(1) The above data indicate that it is possible that differential volume changes may occur in brick masonry between the brick and mortar. A change in temperature alone may cause this. It is indicated, however, that under average climatic conditions, temperature variations may not have so great an effect as variation in the moisture content of the materials.

(2) Among the various mortars studied, those which underwent the smallest volume changes during alternate wetting or drying subsequent to hardening of the mortar, contained only lime and sand.

(3) The extent of shrinkage and expansion produced by varying the moisture content was much less in hard-fired (or well-fired) brick than in any of the masonry and Portland cement mortars. The difference was not so great when the lime mortars were compared with the brick.

(4) From the standpoint of volume changes subsequent to hardening, there should be less differential volume change if the mortar consists solely of lime and sand. This statement refers to conditions that would exist only when brick that are not underfired are used.

(5) Insofar as shrinkage and expansion of the mortars are concerned, the data indicate that it is hardly worth while to use a 1:4 in preference to a 1:3 mortar in brick masonry construction.

(6) The volume changes subsequent to hardening were less in mortar made from 2 volumes of lime:1 volume of Portland cement:9 volumes of sand than in mortar made from 1 volume of Portland cement:3 volumes of sand, using the same cement and sand in both mortars. The data further indicate that from the standpoint of volume changes, there could be no distinct advantage in using a 1 lime:1 Portland cement:6 sand mortar with the cements and limes described in this investigation.

(7) From the standpoint of volume changes both during and subsequent to hardening, there was considerable variation among the masonry cements. This degree of variation was greater than that obtaining among the Portland cements studied.

(8) The initial shrinkage of the lime mortars was greater, in all but one case, than that of the various cement mortars. The exception was masonry cement No. 9. It is believed that the shrinkage of mortars occurring during hardening would be less destructive in masonry than the later volume changes even though the latter are much smaller in magnitude than the former. The possibility of any separation of the unit from the mortar during initial shrinkage would depend on the rate and magnitude of such shrinkage and also on the rate of hardening of the mortar.

(9) The presence of calcium stearate in the mortars studied resulted apparently in diminishing to some extent the rate of expansion and shrinkage occurring subsequent to hardening. It did not diminish the magnitude of volume changes occurring either during or subsequent to hardening.

Acknowledgments The author wishes to express his gratitude to various members of the staff of the Bureau of Standards, to R. H. Bogue, Senior Fellow of the Portland Cement Association, to C. C. Connor, of the New Jersey Bell Telephone Co., and to Stanley Newman, of the Stanley Newman Co., Little Building, Boston, Mass. These gentlemen gave advice and assistance during the course of this investigation.

USE OF LEPIDOLITE IN ZINCLESS GLAZES[1]

By H. E. Davis and R. L. Lueders

ABSTRACT

It is well known that among terra cotta colored glazes, chromium greens and chrome-tin pinks are the most susceptible to crazing. This is, no doubt, due to the absence of ZnO from the RO. In an endeavor to introduce into the glaze composition some material of low coefficient of expansion, the natural lithia-bearing mineral lepidolite was tried with fairly satisfactory results.

I. Introduction

Work has been done on the use of lepidolite in regular Bristol glazes containing zinc.[2] The results reported at that time were not very positive. Subsequent research has developed glazes of this type highly resistant to crazing without the use of lepidolite. In fact, the best of these glazes showed absolutely no improvement with the substitution of LiO_2 for a part of the KNaO in the RO. There was, however, a noticeable improvement in the surface texture.

Realizing the difficulties usually encountered in zincless chrome green glazes, the thought occurred that a certain amount of lithia in the composition might be of value, providing it did not react to destroy the coloring power of the chromium. The same should, of course, apply to the chrome-tin pink colors, although these are not covered in the work presented.

II. The Glazes Used

An original series of 5 glazes was prepared introducing lepidolite into the batch in percentage from 15 to 19, replacing SiO_2 in each case.

The empirical formulas of these 5 glazes are shown in Table I.

TABLE I

	Li_2O	KNaO	CaO	BaO	Al_2O_3	SiO_2
1	0.042	0.322	0.506	0.130	0.568	3.060
2	0.044	0.324	0.503	0.129	0.572	3.075
3	0.046	0.326	0.500	0.128	0.576	3.090
4	0.048	0.328	0.497	0.127	0.580	3.105
5	0.050	0.331	0.493	0.126	0.585	3.120

The original series of 5 glazes were sprayed on 3 and 6 samples only for testing in an autoclave. A second series was laid out composed of 16 glaze members in one group of 4 and 4 groups of 3.

No.							
1–4	Decrease Li_2O		Increase KNaO		Other constituents constant		
5–7	"	Li_2O and CaO	"	KNaO and BaO	"	"	"
8–10	"	CaO	"	BaO	"	"	"
11–13	"	Li_2O	"	KNaO and SiO_2			
14–16	Increase SiO, other constituents constant						

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received April 16, 1931.

[2] *Jour. Amer. Ceram. Soc.*, **12** [9], 570 (1929).

Table II shows complete empirical formulas for all members.

TABLE II

	Li_2O	$KNaO$	CaO	BaO	Al_2O_3	SiO_2
1	0.035	0.325	0.50	0.14	0.565	3.36
2	0.030	0.330	"	"	"	"
3	0.025	0.335	"	"	"	"
4	0.020	0.340	"	"	"	"
5	0.030	0.330	0.48	0.16	"	"
6	0.025	0.335	0.46	0.18	"	"
7	0.020	0.340	0.44	0.20	"	"
8	0.035	0.325	0.48	0.16	"	"
9	"	"	0.46	0.18	"	"
10	"	"	0.44	0.20	"	"
11	0.030	0.330	0.50	0.14	"	3.39
12	0.025	0.335	"	"	"	3.42
13	0.020	0.340	"	"	"	3.45
14	0.035	0.325	"	"	"	3.39
15	"	"	"	"	"	3.42
16	"	"	"	"	"	3.45

The principal materials used in all these glazes were as follows: soda feldspar, rather high in SiO_2; English ball clay, English china clay, precipitated $BaCO_3$ and $CaCO_3$, and 140-mesh lepidolite from Embudo, New Mexico, with the empirical formulas listed below.

$$\left.\begin{matrix} 0.365\ Li_2O \\ 0.635\ KN_2O \end{matrix}\right\} \quad 1.14\ Al_2O_3 \qquad 5.05\ SiO_2$$

The second series of 16 glazes were sprayed also on 3- by 6-inch tile for the autoclave, and in addition on 3-inch rings for determination of compression.

All test pieces were sprayed in the usual manner and fired in regular commercial kilns to cone 6.

III. Testing

Rings were measured, cut, and re-measured in accordance with the method of Schurecht and Pole.[3] The autoclave treatment was decreased in its severity to differentiate more readily between the weaker members of the series. The treatment used was 125 pounds pressure built up from zero in one hour, and maintained for 30 minutes. All five members of the first group and all 16 members of the second group were tested simultaneously in order to insure uniformity of treatment. The test pieces were allowed to cool slowly and brushed with ink to show up any craze marks in the glaze surface.

IV. Results

No appreciable differences were noted in the compressive movements of the glaze in series No. 2. In all cases, however, the movement was

[3] *Jour. Amer. Ceram. Soc.*, **13** [6], 369 (1930).

fairly high, and within the lower limits accepted as satisfactory for ordinary Bristol glazes, as shown by comparative autoclave tests.

The question at once arises as to the influence of other physical properties, such as modulus of elasticity and tensile strength, which are beyond the limits of this investigation.

The autoclave tests showed a distinct improvement in all 21 members over the original base glaze without lithia, which crazed with a single treatment.

Members 1 and 2 of Series 1 were slightly superior, failing on the third treatment. All other glazes failed on the first or second treatment.

Series No. 1, it will be noted, is higher in lithia and lower in SiO_2 in all cases.

Further increase in SiO_2 in members 11 to 13 and 14 to 16 was detrimental to the results.

Other minor changes in the glaze compositions showed no positive trends in either direction. All glazes have a very pleasing satin mat surface texture and in no case was the green color appreciably affected.

V. Conclusion

In view of the positive improvements effected in resistance to crazing and surface texture without destroying color, it is evident that lepidolite can be of considerable value as an ingredient in zincless glazes. Indications are that with further research along the lines indicated above, zincless glazes may be produced well within the range of safety from moisture crazing.

FEDERAL SEABOARD TERRA COTTA CO.
WOODBRIDGE, N. J.

SOME EFFECTS OF THERMAL SHOCK IN CAUSING CRAZING OF GLAZED CERAMIC WARE[1]

By H. G. Schurecht and D. H. Fuller[2]

ABSTRACT

The characteristics of glazes are too frequently regarded as the only important factor governing the resistance of glazed ware to thermal shock crazing. In this investigation it was found that thermal shock crazing was caused, in some cases, by craze-like cracks which developed in the bodies. The importance of selecting suitable bodies, as a means of controlling crazing, became evident at once when it was found that bodies with a high resistance to thermal shock were not so liable to craze when glazed and subjected to sudden temperature changes as those with a low resistance to thermal shock. In general, glazed ware on which the glazes are under fairly high compression are more resistant to thermal shock crazing than those on which the glaze is under either low compression or tension. Glazed ware which is susceptible to thermal shock crazing may be resistant to moisture crazing and vice versa.

I. Introduction

Crazing of glazed ceramic ware may be divided into two classes. One kind is apparent on the ware upon removal from the kiln, while the other type, known as delayed crazing, first develops some time after it has been fired. It has been shown[3] that one kind of delayed crazing may be caused by a gradual expansion of the body during storage or use and is produced by the action of moisture on certain bodies, while glazes generally do not expand as much. This kind of crazing has been called "moisture crazing" to distinguish it from other types. Another kind of delayed crazing may be caused by thermal shock which the ware receives in service, as has been demonstrated by Stover[4] and others.[5] The following work was done for the purpose of determining the influence of the bodies on the resistance to thermal shock crazing of glazed ware[6] and, incidentally, to compare crazing produced by thermal shock with moisture crazing.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received April 9, 1931.

Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce, and by the National Terra Cotta Society.

[2] Research Associates of the National Terra Cotta Society at the National Bureau of Standards.

[3] H. G. Schurecht, "Methods for Testing Crazing of Glazes Caused by Increases in Size of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **11** [5], 271–77 (1928).

[4] E. C. Stover, "Delayed Crazing and Shivering," *Trans. Amer. Ceram. Soc.*, **11**, 88–92 (1909).

[5] (*a*) H. A. Harkort, "A Method of Testing Crazing of White Ware," *ibid.*, **15**, 68 (1913).

(*b*) F. K. Pence, "Crazing Test for Wall Tiles," *ibid.*, **18**, 622–30 (1916).

(*c*) H. H. Sortwell, "Comparative Tests of American and Foreign Tableware," *Jour. Amer. Ceram. Soc.*, **5**, 276–88 (1922).

[6] The specimens referred to in this paper were glazed on one side only.

The results to date indicate that crazing of glazed ware may originate from craze-like cracks which develop in the body from thermal shock. The results obtained would indicate that a knowledge of this cause of crazing is of fundamental importance in producing glazed ware which will not craze. It has been shown previously[7] that glazes under compression are better able to withstand moisture crazing than those under either slight compression or tension. It was also shown that glazed ware on which the glaze was under high compression was more resistant to thermal shock crazing than ware on which the glaze was under either slight compression or tension.

II. Experimental Methods

Three series of tests were conducted in this investigation as follows:

Series 1 In the first series twelve different mat glazes, each applied on one of twelve different commercial bodies, were investigated. Glazed specimens, together with duplicates of the bodies with no glaze, were fired to cone 6. The resistance of the glazed specimens to thermal shock crazing, the tendency of the bodies to crack from sudden temperature changes, the "fit" between glaze and body, and the resistance to moisture crazing were determined on these specimens. Thermal shock crazing tests were conducted by heating 4- by 4- by 1-inch tile, glazed on one face and ground smooth along the sides to make the body cracks more perceptible. They were heated in an oven to 120°C and quenched in water at room temperature. This treatment was repeated until most of the glazes crazed. The average number of cycles at which crazing first developed on three duplicate tile was used as an indication of their resistance to thermal shock crazing. The bodies were inspected for cracks which formed during these quenching treatments. Three duplicate 4- by 4- by 1-inch glazed tile were subjected also to a moisture crazing test.[8] This was done by exposing the tile to steam for one hour at a pressure of 150 pounds per square inch. In spite of extreme care in inspecting these tile, it was difficult to detect body cracks on some of the specimens. Accordingly, in a second series of tests described below, the decrease in strength of 1- by 1- by 6-inch bars when subjected to these treatments was determined instead. Two-inch hollow cylindrical rings were employed as previously described,[9] to measure the "fit" between glazes and bodies. This determination was made on three duplicate rings in each case and their average was reported.

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[7] "Method of Measuring Strains between Glazes and Ceramic Bodies," Bur. Stand., *Jour. Research*, **5**, 97–103 (1930); *Jour. Amer. Ceram. Soc.*, **13**, 369–75 (1930).

[8] "Methods for Testing Crazing of Glazes Caused by Increases in Size of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **11**, [5], 277 (1928).

[9] See footnote 7.

Series 2 In the second series of tests, one slip glaze was applied on each one of twelve different experimental bodies with varying silica contents and a duplicate set of each of the bodies was left unglazed. Potter's flint was added in some cases to study the effects of uncombined silica in bodies upon thermal shock crazing. The silica contents of these bodies (Table II) represent the combined amount of silica added as potter's flint together with that originally present in the clays in excess of the combined silica in the kaolinite of the clays as determined by chemical analysis. The specimens were used for the determination of (1) the resistance to thermal shock crazing, (2) the "fit" between glaze and body,

TABLE I

SHOWING RELATION OF SOME PROPERTIES OF GLAZED BODIES TO THERMAL SHOCK CRAZING AND MOISTURE CRAZING

(All glazed ware was free from crazing before testing)

Commercial body No.	Thermal shock crazing (number of quenchings from 120°C in air to water at room temperature at which 4- by 4- by 1-in. tile crazed)		Contraction of rings (cm.) (variation between individual specimens = ±0.001 cm.)†	Moisture crazing (appearance of glaze after 4- by 4- by 1-in. tile were treated with steam at a pressure of 150 lb./sq. in. for 1 hr.)
	Glaze	Body*		
1	2	(2) ?	0.0155	Crazed
2	4	5	0.0135	O. K.
3	5	14	0.0065	Crazed
4	5	5	0.0175	O. K.
5	6	35+	0.0115	Crazed
6	6	5	0.0105	O. K.
7	6	12	0.0020	Crazed
8	7	11	0.0090	Crazed
9	9	10	0.0160	O. K.
10	15	17	0.0125	O. K.
11	17	15	0.0195	Crazed
12	33+	(13) ?	0.0150	O. K.

* The sides of the tile, which had been ground smooth, were examined for body cracks. These cracks were difficult to detect in some bodies. Therefore, these data are only approximate.

† Indicates glazes are in compression.

(3) the decrease in strength of unglazed specimens caused by thermal shock, and (4) the per cent absorption. To ascertain the decrease in strength of the bodies because of thermal shock, the cross-breaking strengths of unglazed 1- by 1- by 6-inch bars were determined before and after 25 quenchings from 120°C in air to water at room temperature. The average modulus of rupture of ten specimens, using a five-inch span, was used as a measurement of their strength. The per cent decrease in strength was calculated in terms of the original strength. Similar tests were also conducted to determine the decrease in strength caused by 75 quenchings from 60°C in air to water at room temperature (approximately 20°C).

Series 3 In the third series four groups were prepared. Two were glazes and two were standard finishes. All were studied to determine their relative resistance to thermal shock crazing by subjecting

them to a maximum of five quenchings from 120°C to water at room temperature or until crazing occurred.

III. Results

Series 1 The results of the first series of tests are given in Table I. Specimen 2 is susceptible to thermal shock crazing, but has good resistance to moisture crazing, while specimen 11 possesses good resistance to thermal shock crazing, but is susceptible to moisture crazing. This indicates that glazed ware which has good resistance to thermal shock crazing may develop moisture crazing and vice versa. Although a compressive stress in the glaze usually prevents moisture crazing, it is not a protection against thermal shock where the thermal treatment results in cracking of the body. For example, the ring and thermal shock crazing tests (Table I) show that glazed ware may have poor resistance to thermal shock crazing even when the glaze is under considerable compression, as was the case with specimens 1, 2, and 4. During the test an examination of specimens 6, 11, and 12 while subjected to thermal shock showed that craze-like cracks had first developed in the body and then extended through the glaze (see Fig. 1). It was apparent that crazing of the glaze in these cases originated from body cracks.[10]

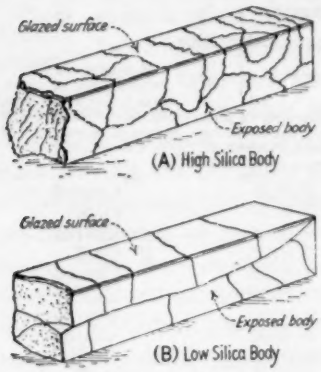


FIG. 1.—Appearance of some glazed bars after quenching from 120°C to water at 20°C 25 times.

With some high silica bodies the cracks in both body and glaze had a zigzag shape (Fig. 1*A*), while most of the low silica bodies which crazed developed smooth cracks (Fig. 1*B*). The fact that zigzag cracks appeared in the glaze on high silica bodies as continuations of similar cracks in the body further supports the theory that this crazing originated from body cracks, especially since cracks originating in the glaze are normally smooth. Moreover, crazing of glazes produced by autoclave treatment on these same high silica specimens appeared as smooth cracks.

Although the hair-like cracks in the bodies were easily seen on some specimens after applying ink, they were difficult to detect on others. In the second series of tests, therefore, the decrease in strength of the bodies caused by thermal shock was used as a measurement of their

[10] While conducting thermal shock tests of glazed plates, Sortwell (see footnote 5*c*) noticed that in some cases a fracture developed at the point where glaze and body met. It is possible that the fractures observed were body cracks similar to those described above.

resistance to cracking instead of the more inaccurate method of inspecting the bodies for visible cracks.

Series 2 The results of the second series of tests are given in Table II. It is apparent that the glazed specimens are most resistant to thermal shock crazing when the body does not decrease in strength materially, with the exception of body 9 when the glaze is under fairly high

TABLE II

SOME PROPERTIES OF GLAZED WARE AND BODIES AS RELATED TO RESISTANCE TO CRAZING

(All specimens were free from crazing before testing)

Laboratory body No.	No. of quenchings from 120°C in air to 20°C in water at which 4- by 4- by 1-in. tile crazed	Expansion (+) or contraction (−) of rings (cm.)* (variation between individual specimens +0.001 cm.)	Decrease in strength of unglazed 6- by 1- by 1-in. bars, in terms of original strength (%)		Water absorption after 2 hours boiling and 48 hours soaking (%)	Free silica in body (%)
			After 25 quenchings from 120°C in air to water at room temp.	After 75 quenchings from 60°C in air to water at room temp.		
1	1	+0.0035	79.8	7.0	13.1	2.50
2	1	+0.0020	66.2	15.4	3.3	5.79
3	1	+0.0020	61.7	0.0	0.5	5.10
4	1	−0.0005	27.7	9.0	10.8	19.70
5	1	+0.0085	23.4	12.2	7.3	31.54
6	1	−0.0095	51.2	0.0	17.7	19.10
7	2	−0.0195	44.6	21.1	13.4	46.20
8	2	−0.0015	10.3	19.3	8.0	46.50
9	5+	+0.0005	5.1	4.5	12.4	31.10
10	5+	−0.0310	0.2	5.4	16.0	29.90
11	5+	−0.0465	0.2	1.7	14.4	46.20
12	5+	−0.0840	15.9	4.4	19.1	45.90

* Positive values indicate that the glasses are in tension and negative values that they are in compression.

compression. This relationship is shown more clearly in Fig. 2. No close relation could be detected between either the absorptions or the free silica contents of the bodies and their resistance to thermal shock crazing. The majority of glazed bodies high in silica, however, appear to be more resistant to thermal shock crazing than the majority of glazed bodies low in silica.

The properties of glazes are too often regarded as the only important factors controlling the crazing of glazed ware. Although these properties are factors, the importance of selecting suitable bodies should be evident when it is considered that glazed ware made with bodies having a low resistance to thermal shock are likely to craze because of body failures no matter how well the glaze may "fit" the body.

Tests conducted by quenching from 60°C to water at room temperature show decreases in strength, but the values are not as significant as those obtained by quenching from 120°C to water at room temperature. Quenching from 60°C as a means of testing the resistance of bodies to thermal

shock would be too time-consuming; therefore the method of quenching from 120°C in air to water at room temperature is suggested as more satisfactory for an accelerated laboratory test.

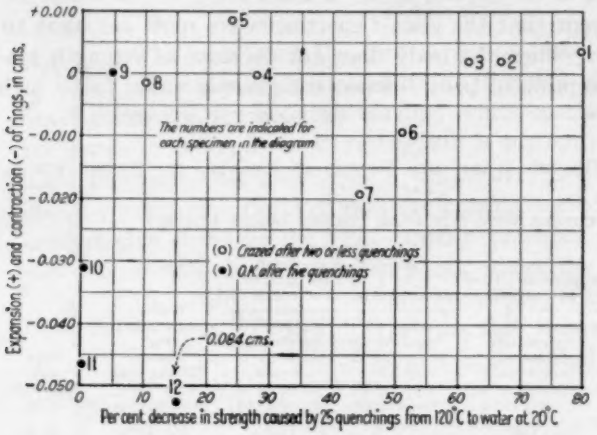


FIG. 2.—Resistance to thermal shock crazing of slip-glazed bodies with varying expansions and contractions of rings and different decreases in strengths of the bodies caused by quenching treatments.

Series 3 The results of the third series of tests are given in Table III. All of these ceramic finishes crazed on bodies 2 and 3 after one quenching, while on bodies 8 and 11 they all withstood the five quenchings. On most of the bodies (Nos. 1, 4, 5, 6, 7, 9, 10, and 12), however, some finishes proved to be more resistant to thermal shock crazing than others. In general, the porous standard finish was found to be most resistant to crazing, the mat glaze ranked next, the vitreous standard finish next, and the lustrous glaze proved to be least resistant to thermal shock crazing.

TABLE III

RESISTANCE TO THERMAL SHOCK CRAZING OF GLAZED SPECIMENS USING TWO GLAZES AND TWO STANDARD FINISHES ON 12 DIFFERENT EXPERIMENTAL BODIES

(All specimens were free from crazing before testing)

Laboratory body No.	Number of quenchings from 120°C to water at room temperatures on 4- by 4- by 1-in. tile before crazing occurred			
	Lustrous glaze	Mat glaze	Vitreous standard finish	Porous standard finish
1	2	5+	1	5+
2	1	1	1	1
3	1	1	1	1
4	4	5	1	
5	1	1	1	5+
6	1	1	2	5+
7	5+	2	2	5+
8	5+	5+	5+	5+
9	2	5+	5+	
10	2	5+	5+	5+
11	5+	5+	5+	5+
12	1	1	5+	5+

IV. Conclusions

(1) The properties of glazes are too frequently regarded as the only important factors affecting the crazing of glazed ceramic ware. It was demonstrated that ceramic bodies which become cracked from sudden temperature changes may cause glazed ware to develop a type of thermal shock crazing. A knowledge of the resistance of ceramic bodies to sudden temperature changes is, therefore, also of fundamental importance for the production of glazed ceramic ware resistant to thermal shock crazing.

(2) In general, glazed ware on which the glazes are under high compression are more resistant to thermal shock crazing than those on which the glazes are under either low compression or tension.

(3) No relation could be detected between the absorptions of the bodies and their resistance to thermal shock crazing.

(4) In general, high silica bodies were found to be more resistant to thermal shock crazing than low silica bodies.

(5) Resistance of glazed ware to thermal shock crazing is by no means an indication that the glazed ware is resistant to moisture crazing and vice versa.

(6) In general, a porous standard finish was found to be most resistant to crazing produced by thermal shock, a mat glaze ranked next, a vitreous standard finish next, and a lustrous glaze proved to be least resistant.

(7) Quenching glazed ware from 120°C in air to water at room temperatures (approximately 20°C) is suggested for further research as an accelerated laboratory method of testing the resistance of ceramic ware to thermal shock crazing. When conducting such tests it is important to note the effect of the treatments on the body.

BUREAU OF STANDARDS
WASHINGTON, D. C.

APPLICATION OF THE DOWNDRAFT PRINCIPLE TO TUNNEL KILNS[1]

By W. D. Richardson

ABSTRACT

Down draft is established as best for producing even heat distribution in periodic and chamber kilns. Methods of applying down draft to tunnel kilns are described and illustrated.

I. Introduction

Notwithstanding the large amount of information that has been published on methods of firing clayware, previously-used processes are rediscovered and in some cases are patented as new inventions.

The round or rectangular downdraft kiln is the most common type in this country. The downdraft principle is correct and the downdraft kiln, with proper furnaces, distributing flues, and draft, is the only type of kiln in which a fairly uniform degree of hardness of the ware can be assured throughout a large body of setting.

II. Downdraft Continuous Kilns

The downdraft principle has also been successfully applied to progressing-fire compartment kilns, each compartment being a downdraft kiln, fired on one or two sides with coal, oil, or gas from the top into special combustion bags or fire walls.

Just as the producer gas-fired compartment kiln had reached a high state of perfection, the car tunnel kiln with its stationary fires was introduced and is now fast superseding all other types.

(1) Defects of Tunnel Kiln for Natural Clayware

In using the tunnel kilns for common- or natural-clay products, the clays having a somewhat narrow firing range and the products a low tonnage value, certain inherent defects of the tunnel kiln have been encountered:

(1) The narrow tunnel that is practical in firing fine ceramics has too small an output to be economical for what is called "heavy clay products."

(2) Making the tunnel wider or protecting the ware by combustion bags from the direct action of the flame, leaves the lower part of the setting underfired, because the kiln or tunnel is also the main draft flue and the draft fan pulls the combustion gases over the top of the contact with the ware in the bottom part of the car.

(3) In attempting to relieve this trouble by lessening the space between the top of the setting and the arch over the tunnel and thereby preventing too great overdraft, the tops of the setting are overfired.

(4) Another method of relieving this trouble (in the last or forward end of the firing zone) is by checking the draft on the kiln, so that there will be a back draft or balanced draft near the end of the firing zone. This causes

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Received January 22, 1931.

some of the unconsumed gases from the furnace to pass along the ware on the cars and burn in the bottom part of the seting, increasing the heat there. By this means a reducing atmosphere and the flashing of the wear result, which is not always desirable and is often the cause of deformation and displacement, a more serious matter in the tunnel kiln than in other types of kilns.

This inherent defect of the tunnel kiln must be overcome before it can be claimed to be the suitable kiln for structural ceramic ware.

III. Two Successful Kilns

To make the tunnel kiln a success in the firing of structural clay products, it must be made down draft, the combustion gases passing entirely through the ware into the platform of the cars, the longitudinal draft of the tunnel being checked at frequent intervals by solid barriers or baffles. At first this appeared to be a simple problem, but much study was required before a practical solution was found.

The purpose of this paper is to show how this problem has been solved in two tunnel kilns now on the market, one invented by Wm. Drayton, built and operated by him for firing high-grade face brick at the plant of the Greendale Brick Company, Greendale, Ohio, and the other kiln designed by the writer.

(1) The Drayton Kiln

In the Drayton kiln, the baffles that divide the tunnel into compartments are on separate cars, 4 feet long, spaced 30 feet apart. The movement of cars in such a kiln is intermittent. When the three cars of brick, each ten feet long, have been matured in the last firing compartment, the dampers are drawn from the baffle cars and an efficient mechanism moves all of the cars through the tunnel 34 feet, by pushing into the tunnel three cars and the 4-foot baffle car. This movement occupies only 5 to 10 minutes without interfering with the firing. Refractory dampers by an ingenious mechanical movement are pushed against the sides of the baffles and are also

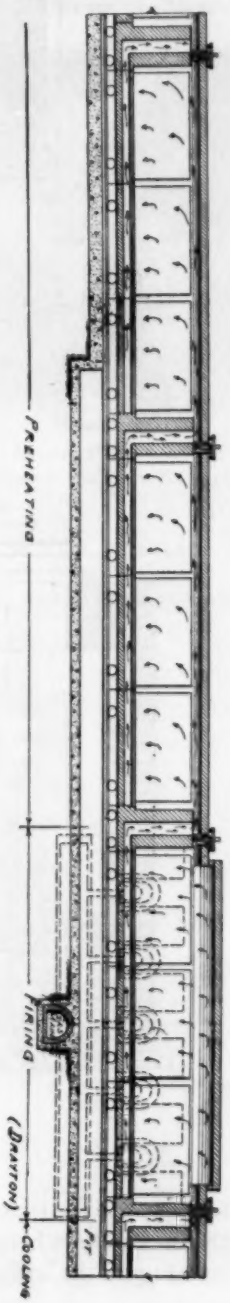


FIG. 1.

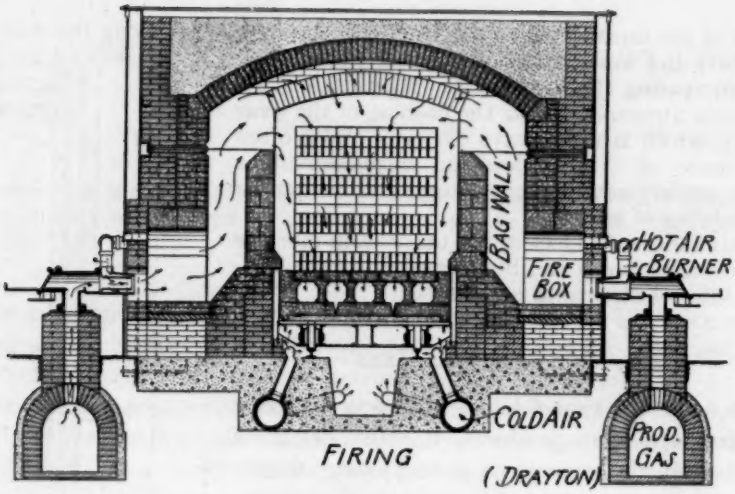


FIG. 2.

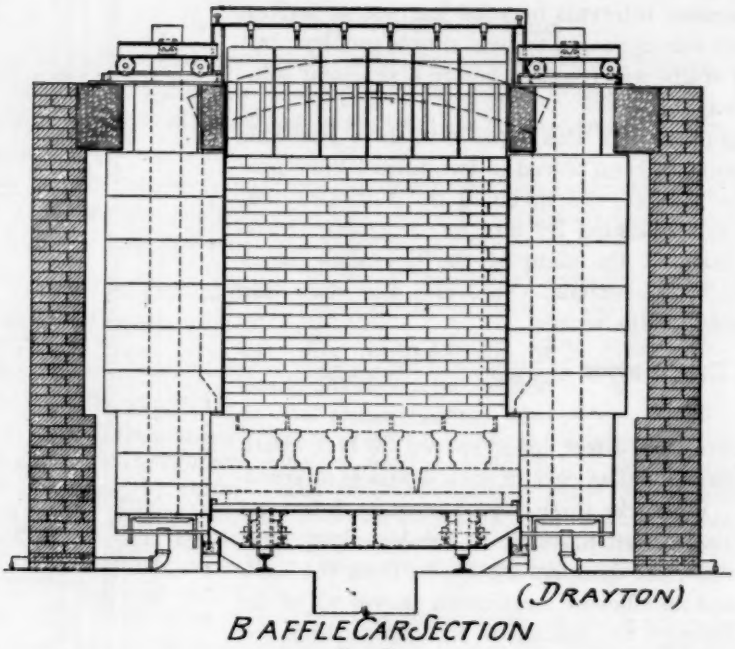


FIG. 3.

let down on the tops, thus dividing the tunnel into separate compartments, the only outlets being the flues in the car platforms connecting with flues rising up in the baffle car, through which the gases pass into the next com-

partment. This structure makes of the tunnel kiln a series of downdraft kilns, connected in a single row, and insures the thorough firing of the ware from the top to the bottom with the systematic control that this type of kiln gives.

(2) The Richardson Kiln The Richardson downdraft tunnel kiln necessarily has the same essential features of combustion bags in the firing zone protecting the ware on the sides of the cars from direct impact of the furnace fires, down draft into the platform of the car, the tunnel divided into compartments and intermittent moving of cars. The special features of the Richardson kiln are as follows:

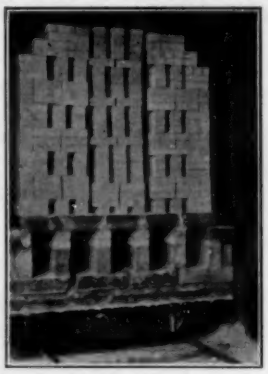


FIG. 4.—Fired face brick. Drayton downdraft tunnel kiln.

(1) Combustion bags, circular on the inside and straight on the outside, that remain true to form.

(2) Flat suspended arch over tunnel, the most durable type of arch.

(3) Baffle constructed on the rear end of every third car, instead of on a separate car.

(4) Baffle with a tilting damper on top registering automatically with a drop arch at the end of every movement of cars.

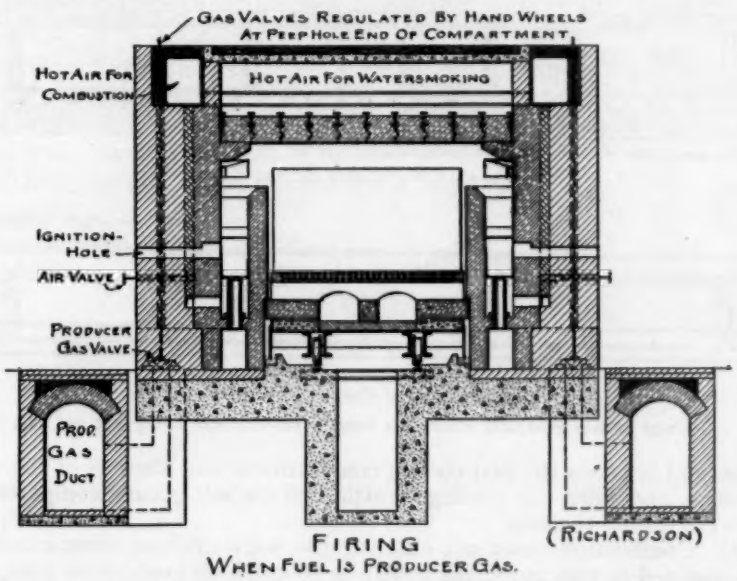


FIG. 5.—Hot air ducts for combustion would be generally below the floor line. Longitudinal flues in car platform would be one or three, depending upon width of car.

(5) One or three longitudinal draft flues in every car platform, with multiple cross-flues and with provision in the baffle for dampering when desired, as between the watersmoking compartments and the preheating zone, between the last firing compartment and the first cooling compart-

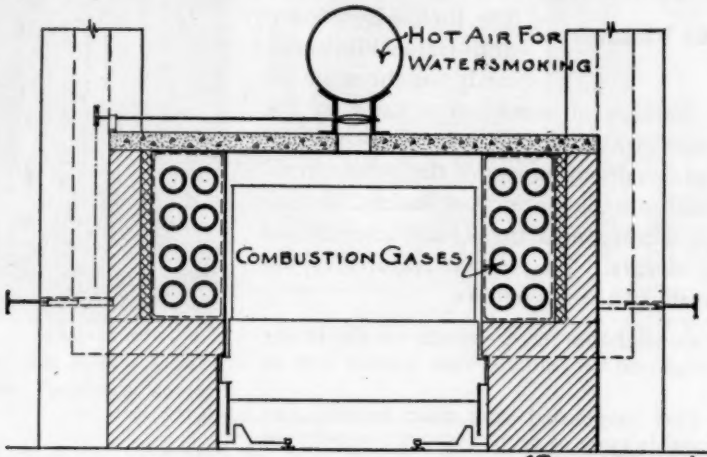
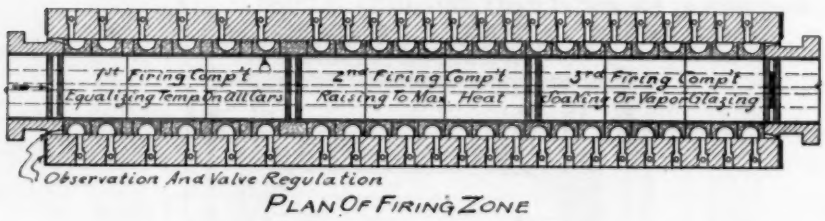
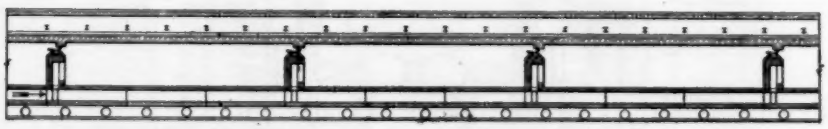


FIG. 6.



PLAN OF FIRING ZONE



ELEVATION OF FIRING ZONE

FIG. 7.—Drop arches generally every car length, movements being one car at a time.

ment, and between the first cooling compartment and the rest of the cooling zone, and when salt glazing, shutting off the salt glazing compartment from the rest of the kiln.

(6) Combustion gases not entering the watersmoking compartments, but confined in iron pipes, the radiation from which heats these compartments. In addition to this radiated heat, air heated by radiation of the flat suspended arch over the first cooling compartment and over the firing

zone is blown into the watersmoking compartments, the vapor being drawn out by separate stacks or by fan.

(7) Provision for observing all of the fires on each side of the compartments in the firing zone at the same time, at the top of the bag walls and the tops of the cars, and when producer gas is being burned, regulating each fire at the observation hole.

(8) The cars are moved through the kiln intermittently, either one car at a time or three cars, depending upon local conditions. It is not considered necessary to damper the narrow slot between the pilasters on the inside of the tunnel walls and the baffle, since the hot gases that may pass through this slot help to keep the inner walls of the tunnel nearer to the temperature of the central part.

The downdraft tunnel kiln is practically impossible to use without baffles or movable partitions at regular intervals. These baffles or partitions serve also another useful purpose in the tunnel kilns. In other forms of open-fire tunnel kilns, the setting must be uniformly high and as high as possible, so as to leave the same narrow space between the top of the setting and the arch over the tunnel, resulting often in an overfired top. The downdraft tunnel kiln is therefore more flexible than other forms of the tunnel kiln, since higher or lower settings do not affect the operation of the kiln or the results of the firing. This means that the daily output may be adjusted to the demand.

Another advantage of the downdraft tunnel kiln is the better control of the kiln atmosphere that it gives, making it easy to maintain oxidizing or reducing conditions. Thus clear, solid, uniform colors may be secured in every part of the car even nearest to the fire, or reducing gases may be distributed through the whole car, producing the full range of beautifully flashed colors. The best salt glazes as well as colors which have been obtained from the volatilization of mineral oxides and metals may be produced with this kiln in the shortest firing time.

SCHULTZ BUILDING
COLUMBUS, OHIO

ORIGIN OF THE COLOR PRODUCED ON RED BODIES BY ZINC VAPOR[1]

By A. McKinley Greaves-Walker

ABSTRACT

The green color produced by zinc vapor on clays that fire to a red color is not due to the formation of a compound of that color but to the absorption of certain rays of the light spectrum by the yellow zinc glaze and the bluish reduced zone beneath it.

To obtain good green colors it is necessary to have the surface of the body reduced to a good blue color. Greens may be produced during the glazing period and lost during the cooling period due to re-oxidation of the surface of the product. A zinc process is given in detail.

I. Introduction

In zinc glazing, as in salt glazing, the ware must be carried to good vitrification before the reaction between the zinc and the clay can properly take place.

When the finishing point of the ware is reached the furnaces should be thoroughly cleaned and refueled, so as to produce a heavy bed of white hot coke. This hot fuel bed is important.

When all of the volatile matter has been driven off and the coke is at white heat, the feeding of the zinc should be accomplished as rapidly as possible. The zinc should be thrown back against the bag walls where the highest temperature usually is found. As soon as the proper amount of zinc has been fed to a furnace the door should be immediately closed or if no door is provided, the firing eye should be tightly closed with slack coal, so as to eliminate excess air.

As soon as the last furnace is fed, the damper is dropped to within three or four inches of the bottom of the flue and the kiln allowed to soak thus for 20 minutes. At the end of this period, the damper is raised and the zincing is repeated.

The amount of zinc required varies considerably with the clay. Two hundred pounds may be considered the minimum and six hundred the maximum. Whatever the amount used, it is best to divide it into three feedings at 20-minute intervals.

At the end of the third and last feeding, the damper should be left about four inches from the bottom for one hour. At this time, the furnaces should be closed tight and the kiln allowed to soak. At the end of the hour, the damper is dropped completely and the kiln allowed to stand at least 24 hours before it is connected to the drier.[2]

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division).

[2] A. F. Greaves-Walker, "Color Burned into Face Brick," *Brick Clay Rec.*, **76** [9], 574 (1930).

II. Colors Produced

Pig or moss zinc produces the best greens and blue greens. Scrap zinc, often used with poor results because of the impurities it contains, will tend to produce mustard greens or yellows. Salt is sometimes added to the zinc in equal proportions. This has no effect on the color but a more brilliant glaze is usually produced. Pig zinc should always be broken up as finely as possible to aid volatilization and to prevent heavy loss through the grates.

Fair uniformity of color of zinc greens is practically impossible because of the large number of factors that must be controlled. Frequently a standardized method of zincing will get good greens from one firing and mustards from the next in the same kiln. Pure pig or moss zinc almost always gives mustard greens, but occasionally no green at all. Evidently then, there is involved an important control factor which has been overlooked or not understood.

III. Study of the Case

A number of sample brick were collected from plants producing zinc greens on the red firing pre-Cambrian and Triassic shales of the Piedmont section of the Carolinas. All of these were studied under a mineralogical microscope and thin sections were cut from several for study under a petrographic microscope.

(1) Petrographic Microscope

Some of the sections[3] were cut parallel to and some perpendicular to the surface of the brick. All of the parallel sections were cut from smooth surfaces, but after preparation the glaze was only visible in pockets or cavities.

It had been assumed that the green coloration was due to the formation of a definite zinc mineral of that color, several of which exist. No definite minerals, however, could be found in any of the thin sections that might relate to the color obtained. The magnification used was 380 diameters which would have shown any crystallization, if present.

In the case of even the darkest green samples glazed with pure zinc, the glaze, under the microscope, showed no trace of green color but appeared to be a transparent amorphous light yellow glass. Beneath this glass in all cases was a thin bluish reduced zone. In this reduced zone only one mineral, quartz, could be distinguished and identified beyond doubt. In all of the slides the quartz appears the same. It is sprinkled throughout the entire reduced zone and body of the brick in small grains.

The reduced zone of the good greens never penetrated to any great depth, usually from $^1/_{64}$ to $^1/_{32}$ inch. The thickness of the yellow glass or glaze proved to be, from the perpendicularly cut sections, variable in thickness but never more than an immeasurably thin skin.

[3] Prepared by W. Harold Tomlinson, Swarthmore, Pa.

(2) Mineralogical Microscope Chips from all the brick collected were studied under this microscope and in every case the sample showed the same bluish black reduced zone coated with a skin of yellow glass.

The surface of the brick glazed with scrap zinc usually had a mustard yellow color and the glass was invariably thicker and brighter than on those glazed with pure zinc. It is important to note too, that this glass was usually somewhat opaque and of a deeper color, sometimes shading toward a brown. In some cases also, especially where the glass was comparatively thick, cluster crystallization on the surface was observed, which made it definitely opaque. The appearance of these crystals closely resembles those produced in zinc-titanium glazes. These radial crystals probably owe their origin to the percentage of titanium present as shown in the analysis. In the case of every sample studied the clay from which it was made contained 2% or more of titanium in some form.

The surface produced by scrap zinc appears brighter, in general, than when produced by pure zinc. This would be expected, as the scrap zinc contains, as impurities, other fluxes such as lead, iron, etc. It is the presence of these impurities, especially the relatively high content of iron, that produces an opaque glass rather than a transparent one.

On the surface of some brick glazed with pure zinc was noted some areas distinctly yellow instead of green. It was found that these areas occurred most pronounced on brick set near the bag walls and that they corresponded to the openings or flues in the setting. Adhering to the surface and imbedded in the glass was a film of minute particles having a vesicular structure. These were particles of coal ash and when isolated showed a buff color.

IV. Cause of Green Color

The glass on the brick glazed with pure zinc is light yellow in color but is transparent, in which case it would be expected that the purplish-blue reduced zone beneath it would be visible. As is well known, however, the combination of yellow and blue produces green and therefore to the eye this color appears on the brick. The depth of the yellow and blue colors offers a multi-range of shades of green which accounts for the range and variation in the shades produced in the same kiln.

The yellow glass is comparatively easy to produce. The bluish reduced zone, however, is just the opposite.

It was found that the color of this zone varied considerably even in brick from the same firing.

The thickness or depth of this zone is not important but the extent of the reduction which takes place in it is very much so. Under the microscope, the reduced zone which produced the best greens showed some of

the iron in the ferric phase mixed with a considerably larger amount of silicate in the ferrous or blue-black phase. This gave the zone a decidedly purple-blue color. In the samples which showed that heavy reduction had taken place the zone was black and the color of the brick appeared to be either black or more often "mustard."

When these "mustard" colors appeared on brick glazed with pure zinc heavy reduction was always indicated and the glass was of deeper shade and opaque. It is assumed that under such conditions the glass takes into solution a sufficient amount of the ferrous aluminium silicate to darken it and give it a mat effect.

Samples were also examined that came from a kiln that had been glazed but which produced only red brick. As trials that showed a desirable green color had been drawn before the kiln was closed down it was evident that the color had been developed and lost. The samples showed the yellow glass but no reduced zone and appeared red. This led to the conclusion that re-oxidation of the reduced zone had taken place during the cooling period and the green color thereby lost.

Were it possible to develop a true blue color in this reduced zone, bright greens such as are obtained by mixing pigments would result. This, however, is not the case. The nearest approach to a blue that is possible is a purple-blue color. This color under the yellow glass gives a dark or bottle green.

It is evident from the above that the ability to control, during the glazing period, the correct amount of reduction of the red body and to hold it during the cooling period will determine the shade of green obtained in the finished product; in fact, it may be considered the governing factor. Exact control of the fires and the damper with correct timing and prevention of re-oxidization during the cooling should produce uniform results from kiln to kiln.

(1) Theory of Optics The following discussion on the optics of light[4] provides an acceptable explanation of the zinc green color.

An excellent proof of reflection from under the surface is furnished by mixing, in proper proportions, a yellow and a blue powder, or yellow and blue paints. It is commonly imagined that the green color which is produced is a mixture of blue and yellow. Far from it! When a disk divided into alternate sectors, colored with the same blue and yellow pigments, is made to rotate rapidly in its own plane, it of course produces on the eye the true result of a mixture of these blue and yellow colors. This depends for its exact tint on the pigments employed, and on the angle of the sectors, but is usually faint pink or muddy purple, utterly different from the green produced by mixing the powders or the paints.

Hemholtz was the first to point out the true source of the green. It is the one color which is not freely absorbed either by the yellow or blue pigment. For the scattered

[4] Encyclopedia Brittanica, Werner Edition, "Optics of Light," Vol. 14, p. 605.

light by which the mixture is seen comes chiefly from below the surface, and has thus suffered absorption by each of the component pigments. The yellow pigment removes the greater part of the blue, indigo, and violet rays; the blue the greater part of the reds, oranges, and yellows. Thus the light which finally escapes is mainly green.

V. Conclusions

(1) The use of pig or moss zinc for vapor glazing will produce a beautiful and pleasing range of green colored brick. Scrap zinc generally produces "mustards" or yellows.

(2) If the coal used in firing produces considerable fine ash, it will be carried into the setting by the draft, and greatly reduce the number of dark greens, due to the buff-colored ash particles becoming imbedded in and adhering to the glaze.

(3) The green color produced on red bodies by zinc vapor is the result of absorption of certain rays of the light spectrum. The zinc vapor produces a thin, transparent glass, tinted yellow by absorbed iron from the body, on the exposed surfaces of the brick. Under this glass is a thin purplish-blue reduced zone. This bluish reduced zone absorbs most of the longer wave-length rays of the light spectrum and the yellow glass absorbs most of the shorter wave-length rays. The light which does finally escape is mainly green, the middle ray of the light spectrum.

(4) The yellow transparent glaze is easily produced and should be extremely thin.

(5) The purplish-blue reduced zone beneath the yellow glass is absolutely necessary and must be closely controlled in color for uniform results. The proper amount of reduction required for the production of desirable greens should be experimentally determined for the raw material used. Re-oxidation of the reduced zone during cooling must be prevented.

(6) The color of the reduced zone is largely responsible for the variation in shades of green produced in the same firing.

(7) The green color obtained is not the result of the formation of a definite green mineral or minerals.

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A GRAPHICAL REPRESENTATION OF THE MOLECULAR FORMULAS OF CERAMIC GLAZES[1]

By H. H. Holscher and Arthur S. Watts

ABSTRACT

A chart representing average glaze composition, including lead, fritted, Bristol, and porcelain glazes, as plotted against temperature is presented as a means for teaching glaze compositions and for getting a broad view of the constituents of glazes and their variation with temperature. The chart covers the range from cones 015 to 18.

I. Introduction

So far as we are aware no attempt has been made to represent the compositions of the important types of ceramic glazes and their firing temperatures on a single diagram. This paper presents such a diagram, representing the average composition of the lead, fritted, Bristol, and porcelain glaze fields. At the outset, it was realized that glazes vary widely in composition and character, and that any chart which represents composition and firing temperature must necessarily be merely approximate and represent only those glazes which are completely matured and have a bright glossy surface. Molecular formulas are used throughout.

Several types of glazes are rather common in ceramic usage. For the purposes of this study, the discussion has been limited to four types. The ordinary lead glazes have been considered as having limits in firing temperature of cones 015 to 6, the fritted glazes, lead and leadless, from cones 08 to 6, the Bristol glazes from cones 6 to 10, and the porcelain glazes above cone 10. In the case of Bristol glazes and some others, the actual temperatures vary between somewhat wider limits.

Other types of glazes such as lead chromate, crystalline, aventurine, alumina free raw lead glazes, and easily fused enamels are not considered and cannot possibly be represented on a diagram with the more important types of glazes.

II. The Diagram

The diagram shown in Fig. 1 has been based on actual glaze compositions which have been or are in commercial usage. It must be noted that no great accuracy is claimed for the diagram but that it represents a simplified way of teaching glazes or of getting a broad simplified outlook on the field as a whole. Such data when presented as single formulas apparently are unrelated and difficult to interpret or remember.

Some mention must be made of the method of plotting in Fig. 1. For any specific temperature, the values for alumina and silica may be read directly by following from the points on their respective lines over to the scale of ordinates. The RO values, however, are represented by

[1] Received May 26, 1931.

areas, or for a specific temperature, by the vertical distance between the boundary lines of any single RO field. The height of each line above the base line has no meaning. This type of plotting is normally used in the representation of rock compositions. Several areas are represented as

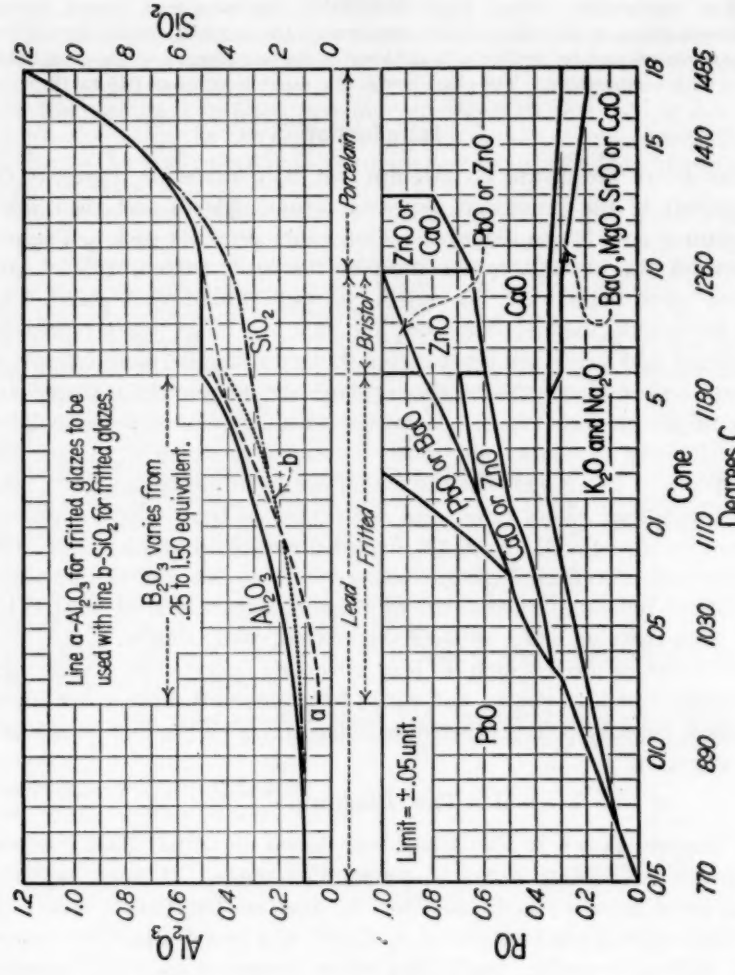

FIG. 1.

being made up of two or more constituents, one or all of which may be present. The reasons for these will be explained later.

The method of reading the graph is shown by the following examples:

For instance, a lead glaze maturing at cone 015 has a composition of

1.0 PbO 0.1 Al_2O_3 1.0 SiO_2

A cone 07 lead glaze has a composition of

0.2 KNaO 0.1 CaO 0.7 PbO	0.15 Al_2O_3	1.3 SiO_2

A cone 6 Bristol glaze has a composition of

0.3 KNaO 0.05 BaO, MgO, SrO, or CaO 0.25 CaO 0.25 ZnO 0.15 PbO or ZnO	0.5 Al_2O_3	3.0 SiO_2

A cone 17 porcelain glaze has a composition of

0.2 KNaO 0.1 BaO, MgO, SrO, or CaO 0.7 CaO	1.0 Al_2O_3	10.0 SiO_2

A discussion will now be given of the various types of glazes and their representation on the diagram.

III. Lead Glazes

The lead glaze field extends from cones 015 to 10, but the range above cone 7 is inserted to account for the small amounts of PbO which are finding their way into Bristol glazes to a certain extent. True lead glazes are not fired much above cones 6 or 7. From the diagram it is seen that CaO starts to come into the glaze formula at about cone 012, while ZnO may replace part of the CaO as low as cone 07. ZnO very definitely comes into the formula at cone 1, and must be present in amounts greater than 0.15 equivalent to give any opacity. The field labeled PbO or BaO is to be considered all PbO if raw lead glazes are being studied while the BaO is inserted to cover the fritted glazes and especially the fritted leadless glazes. The action of BaO is similar to that of PbO if it is introduced in a fritted form. The KNaO content of lead glazes is seen to increase as the firing temperature increases up to about cone 1 when it reaches its maximum. In the range in which the lead glazes overlap with the fritted glazes the PbO content given on the chart is somewhat low for lead glazes and slightly high for fritted glazes.

IV. Fritted Glazes

The fritted glazes mature between cones 08 and 6. BaO replaces PbO if the glaze is entirely leadless and may replace it partially if a fritted lead glaze is desired. In the case of fritted leadless glazes the BaO may be a little higher than indicated. The diagram shows that fritted glazes are exceptionally low in Al_2O_3 (line *a*) because of the presence of B_2O_3. It must be noted, however, that the sum of B_2O_3 and Al_2O_3 is always greater than the normal Al_2O_3 content of a lead glaze which matures at the same temperature as the fritted glaze. Fritted glazes are approximately normal in SiO_2, but in the range of cones 3 to 6 may be slightly

higher than normal (line *b*). It must be noted that B_2O_3 varies in no definite manner; *i.e.*, it may be high in a high-fired glaze and low in a low-fired glaze or vice versa. The limits 0.25 to 1.50 equivalents B_2O_3 are normal. ZnO is necessary in fritted dinnerware and wall tile glazes (from cones 3 to 6) which are somewhat lower in KNaO than is indicated. KNaO in these glazes usually lies between 0.2 and 0.25 equivalent while PbO and CaO make up the difference.

V. Bristol Glazes

Bristol glazes may contain tin oxide which is not considered on the diagram. Bristol glazes containing PbO up to 0.15 equivalent are becoming more popular. They are exceptionally high in Al_2O_3 (0.5 equivalent) and may in some cases be fired as high as cones 12 to 13 and as low as cone 4. These, however, are exceptions to the general rule. MgO, SrO, and BaO are rare constituents and are limited to about 0.05 equivalent total. The SiO_2/Al_2O_3 ratio is lower in Bristol glazes than in porcelain glazes and varies from 6/1 to 8/1.

VI. Porcelain Glazes

The ZnO or CaO field indicated between cones 10 and 13 is made necessary by the electrical porcelain glazes which invariably have ZnO present to some extent. If ordinary porcelain glazes are being studied, this field is to be considered as all CaO. The total of BaO, MgO, and SrO is normally 0.1 equivalent in porcelain glazes. MgO may be slightly higher than this if a dolomitic limestone is used as a raw material, while SrO is a rare constituent of porcelain or any other type of glaze. A small amount of B_2O_3, introduced as borax, may be added as a mineralizer in porcelain glazes. The SiO_2/Al_2O_3 ratio varies from 8/1 up to 12/1 for porcelain glazes but usually lies around 10/1.

VII. Colored Glazes

The glaze compositions indicated are, of course, colorless and any opacifying or coloring material may be substituted in the molecular formula or, if used in small amounts, simply added to the glaze.

VIII. Conclusion

In conclusion, let us state again that no great accuracy is claimed for this diagram since individual glazes may vary considerably from the indicated values which are about average for the temperatures. The chart is offered as a simple way of presenting approximate glaze compositions and shows the relationship between the various types of glazes, a relationship which is not appreciated by one unacquainted with the whole glaze field. The chart provides an easy way to give the beginner an understanding of ceramic glazes. It shows approximately at what

temperature a certain constituent becomes important and at what temperature one constituent is replaced by another.

Finally it allows a prediction of an approximate glaze formula for a certain firing temperature and, conversely, the maturing temperature of a glaze whose molecular formula is known.

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COLORED JEWELRY ENAMELS FOR ART SCHOOL USE[1]

By Kenneth E. Smith

ABSTRACT

The process of producing easily fusible jewelry enamels is outlined, batch weights are listed, and the type of furnace used is shown. This process is applied mainly to enameling in cloisons, although the same type of enamels may be used in other modes. The use of enamels in jewelry making and in silver smithing is almost unlimited.[2]

I. Introduction

The ever-increasing demand for color and the lack of information available for the production of colored jewelry enamels prompted this investigation. The data for the most part are results of class work at Newcomb College, New Orleans, La., in conjunction with the Art School.

Several metals can be covered with glass fused onto them by means of heat. On nickel, zinc, or brass, however, the glass will not adhere successfully.

In ancient times it is certain that the use of colored glass as a decoration for pottery and porcelain was known, but its use upon metal is more doubtful.

There are several ways of applying the enamels but the one most usually employed for jewelry is the cloisonné.

Several small articles were made of both gold and silver with designs soldered to the foundation. The pieces were well burnished and pickled in a dilute solution of acid; the gold in nitric acid and silver in hydrochloric acid.

The enamel ingredients were ground to pass a 20-mesh screen, well mixed by hand, melted at cone 010 or 950°C, stirred, tested by pulling a thread by an iron rod to note freedom from bubbles, and poured into water. They are ground fine and washed thoroughly by decantation until the water is no longer cloudy.

The metal should be well burnished before the powdered enamel is spread into the cloison. Usually the cloisons are made of 22-gage metal and this is about the correct thickness for the enamel.

If the piece is small the flowing of the enamel can be done with a blowpipe, the flame being applied to the under side of the metal, never on the enamel, as the sulphur in the flame will blacken the enamel. If the piece to be enameled is rather large, a small muffle kiln is used. The temperature is raised to about cone 012 or 910°C, a red, even heat, and the metal

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Art Division).

[2] Several pieces illustrating the use of colored enamels made entirely by students at Newcomb College, New Orleans, La., were exhibited by the writer at the American Ceramic Congress, Cleveland, Ohio.

with the enamel spread on it is set inside the kiln on a flat shelf for two minutes. The enamel cools safely without cracking in the air. If too thin, another layer can be spread on, and the piece re-fired. As long as the firing temperature is kept below 940°C the solder on the piece will not melt.

SOME SUCCESSFUL ENAMELS

	Soft base (%)	Hard base (%)		Medium base (%)
White lead	68.8	70.0	Red lead	51.6
Sodium bicarbonate	11.2	10.0	Niter	20.2
Flint	20.0	20.0	Flint	20.0
	100.0	100.0	Boric acid	8.2
				100.0

	Coloring ingredients	(%)
Rich opaque yellow	Commercial uranium	15.0
Dark opaque green	Chromium oxide	8.0
Dark blue	Cobalt oxide	1.0
Opaque black	Manganese oxide	2.0
	Cobalt oxide	0.5
Light transparent green	Copper carbonate	0.5
Luster black	Cobalt oxide	2.6
	Copper carbonate	3.8
	Manganese oxide	3.0
White	Tin oxide	0.5

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A SYSTEMATIC STUDY OF SHEET-IRON COVER ENAMELS[1]

By A. I. Andrews and D. G. Bennett

ABSTRACT

Based on the limits of composition for sheet-iron cover enamels as commercially used, a systematic field of compositions was plotted and studied. The results show the relation between composition and properties of these enamels. The acid-resisting properties were studied and a treatment developed for improving it.

I. Introduction

A systematic investigation of sheet-iron ground-coat enamel compositions[2] led to the present study of cover enamels. It is appreciated that cover enamel compositions are not as simple as ground coats, but it is believed that the present investigation contributes to the understanding of the relations between composition and properties of sheet-iron cover enamels.

Another phase of this problem involved a study of the acid-resisting properties of these enamels and treatments of the finished enamel which improved the acid resistance.

Part I

(A) Field of Investigation

The choice of a field of investigation was based on twelve satisfactory sheet-iron cover enamels, it being desired to work in a field of compositions which are characteristic of the type used in production. The compositions of these twelve enamels were averaged and the maximum and minimum determined for each constituent, the results being approximately as shown in the diagram for sheet-iron cover enamels in a previous paper.[2] From these results it was noted that approximately 75% of the composition of each enamel consisted of feldspar, borax, and flint; therefore, these constituents were varied first holding the other constituents constant. The general formula of these enamels was as follows:

Feldspar	X
Borax	Y $\}=75$
Flint	Z
Soda ash	5
Soda niter	3
Fluorspar	4
Cryolite	10
Antimony oxide	3
	100

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.

[2] A. I. Andrews, "A Systematic Method for Investigation of Sheet-Iron Enamels," *Jour. Amer. Ceram. Soc.*, **13** [7], 489–97 (1930).

To facilitate the work and aid in the interpretation of results, the above three materials, feldspar, borax, and flint, were placed at the apices of a triaxial diagram (see Fig. 1). This diagram was so laid out that the sum of feldspar, borax, and flint at any given point would always total 75%. In other words, these three ingredients were varied among themselves. Any decrease in borax was balanced by an increase in either flint or feldspar, or else the increase was shared by both flint and feldspar.

In using this method it was possible to vary any one of the three constituents from 0 to 75%, while still using the original diagram and basic formula.

The numbered points on the diagram show the compositions actually made and tried out.

(B) Laboratory Methods

(1) Weighing and Mixing The enamel raw materials were weighed to an accuracy of 0.1 gram in 1500-gram batches. The raw batch was well mixed by screening twice through a 20-mesh sieve and then rolling for about 10 minutes on a square of heavy paper.

(2) Smelting The batch was then smelted in a fireclay crucible, placed in a cylindrical gas-fired pot furnace. The crucible was brought to a dull red heat before charging the batch.

The smelting temperature was held at such a point that there was a steady, progressive fusion of the materials. When the mass was entirely molten it was stirred with an iron rod. At this point a thread of enamel was drawn out and tested for elasticity and smoothness, *i.e.*, presence or absence of knots or "seeds." In cases where the thread remained brittle and seeds persisted, the temperature was somewhat sharply raised and held so for a short time. This treatment produced enamels with an elastic thread in all cases. In a few cases where the enamels were high in antimony oxide it was not possible to eliminate all roughness in the thread. It should be noted, however, that many enamels showing this roughness of thread proved to be very good when applied to the metal.

(3) Grinding and Milling The molten enamel was "quenched" by pouring it into a bucket of cold water. It was then dried and ground to pass a 40-mesh screen, in small porcelain jar ball mills. The 40-mesh frit was then milled with 7% Vallendar clay, 7% tin oxide, and 40% water in the same or similar ball mills. The enamel was milled until it left but a small residue on a 100-mesh sieve.

(4) Application and Firing After at least 24 hours aging, the enamel was sprayed on 2- by 4-inch sheet-iron pieces according to standard practice, dried, and fired in an electric furnace.

A cobalt ground coat of the following composition was used in all cases:

Feldspar	28
Borax	30
Flint	16
Soda ash	7
Soda niter	4
Fluorspar	6
Cobalt oxide	1
Manganese dioxide	3
Ferrous oxide	5
	100

The cover enamels were fired at varying temperatures, but with a few exceptions, all fired well in four minutes at 1500°F. Tables I and II give the firing time and temperature for each enamel.

(5) Acid Test The "spot" test was used. Briefly, this consisted of applying a few drops of 10% citric-acid solution to the surface of each enamel. This was allowed to remain 20 minutes. Each

TABLE I

ENAMELS* MADE UP FOR PART I

BATCH WEIGHTS

Enamel No.	0	7	8	9	10	11	12	13	14	15
Feldspar	30.0	22.5	22.5	30.0	37.5	37.5	30.0	15.0	37.5	37.5
Borax	22.5	30.0	22.5	15.0	15.0	22.5	30.0	30.0	7.5	30.0
Flint	22.5	22.5	30.0	30.0	22.5	15.0	15.0	30.0	30.0	7.5

Enamel No.	16	17	18	19	20	21	High	Low	Range
Feldspar	22.5	22.5	45.0	11.2	39.4	39.4	45.0	11.2	33.8
Borax	37.5	15.0	15.0	31.9	3.7	31.9	37.5	7.5	30.0
Flint	15.0	37.5	15.0	31.9	31.9	3.7	37.5	3.7	33.8

Constants in each formula		Constants in each formula	
Na_2CO_3	5	Cryolite	10
$NaNO_3$	3	Sb_2O_3	3
Fluorspar	4		

* See triaxial (Fig. 1).

piece was then washed, dried, and inspected for acid attack. The scale of grading and results are shown in Tables III and IV.

(6) Surface Ratings Each enamel was graded for opacity, gloss, and surface texture. Any faults were noted. These results are to be found in Tables I and II.

The treatment given each enamel in making it acid resistant is given in Part III which takes up this phase of the problem.

(C) Discussion of Results

The basic enamel, No. 0, proved to be very good. The rest of the enamels were then made in the order in which they are numbered, from 7 to 21.

TABLE II

ENAMELS* MADE UP FOR PART I AND THEIR PROPERTIES

	0	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	High	Low	Range
ENAMEL OXIDES (%)																			
KNaO	13.8	14.5	12.6	11.7	13.0	15.0	15.9	13.3	11.2	17.1	16.8	10.5	14.1	13.2	10.5	17.9	17.9	10.5	7.4
CaO	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2		0.1	0.1	0.2	0.1	0.1
Al_2O_3	6.9	5.4	5.2	6.6	8.3	8.7	7.2	3.7	8.0	9.1	5.6	4.9	10.0	2.7	8.3	9.7	10.0	2.7	7.3
B_2O_3	9.6	13.4	9.6	6.6	6.6	9.6	13.4	13.4	2.9	13.5	17.5	6.6	6.6	14.5	1.4	14.5	17.5	1.4	16.1
SiO_2	49.3	45.4	52.4	55.6	52.7	46.3	42.3	48.6	59.0	39.1	38.0	58.5	49.8	48.4	61.3	36.3	61.3	36.3	25.0
Sb_2O_5	3.7	3.9	3.7	3.6	3.6	3.8	3.9	3.9	3.5	3.9	4.1	3.6	3.7	4.0	3.4	4.0	4.1	3.4	0.7
CaF_2	4.7	4.9	4.7	4.5	4.5	4.7	4.9	4.9	4.3	4.9	5.1	4.5	4.5	4.8	4.3	5.0	5.1	4.3	0.8
Na_3AlF_6	11.7	12.2	11.7	11.2	11.2	11.7	12.2	12.2	10.8	12.3	12.8	11.2	11.2	12.4	10.7	12.4	12.8	10.7	2.1
ENAMEL RATINGS**																			
Surface	1	2	2	2	1	3	3	1	1	2	3	1	2	1	2	3			
Opacity	1	1	1	1	1	1	1	1	3	1	1	1	1	1	3	2			
Gloss	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	2			
Acid resistance	3	3	2	2	2	3	3	3	2	3	3	2	3	3	1	3			
Firing time	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4			
Firing temp.	1500	1500	1550	1600	1500	1500	1500	1500	1500	1500	1500	1550	1550	1500	1600	1500			
Faults‡		sl. p.	sl. p.	sl. p.		sl. p.	sl. p.			sl. p.	sl. p.		sl. d.		d.	sl. p.			
Materials, cost† of frit per pound	3.2	3.5	3.1	2.8	2.9	3.2	3.5	3.4	2.6	3.6	3.9	2.8	2.9	3.5	2.4	3.7	3.9	2.4	1.5
Smelting time	1:30	1:25	2:00	2:30	2:00	1:40	1:40	1:20	1:50	1:15	1:15	1:45	1:30	1:30	1:55	1:15	2:30	1:15	1:15
Temp. (°F)	1900	1900	1900	2000	2000	1900	1900	2040	2280	2000	1940	2240	2190	2060	2360	1920	2360	1900	460

* See Fig. 1.

** 1 = excellent, 2 = good, 3 = fair, 4 = poor.

† Prices taken from issue of *Ceram. Ind.*, March, 1930.

‡ d., dull; p., pinholed; sl., slightly.

(See Fig. 1.) It was found that the best enamels lie below the line *B-B*. Those near the line were superior in opacity and of soft velvety luster. Those further down lost some of this soft luster and became harder and more glassy. They excelled, however, in acid resistance. Note that the enamels below the line *A-A* gave the best acid resistance.

Enamels 8 and 9 were slightly pinholed, but not badly enough to cause their rejection. They were fair enamels.

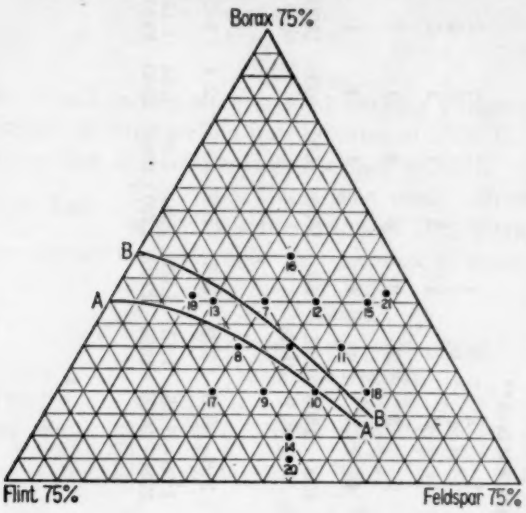

FIG. 1.—Best acid resistance below line *A-A*; best enamels below line *B-B*; enamels above line *B-B* were pinholed. Variation of feldspar, borax, and flint (thesis problem, Part I):

Variables	75
Na_2CO_3	5
$NaNO_3$	3
Cryolite	10
Fluorspar	4
Sb_2O_4	3
	100

Above the line *B-B* all of the enamels were pinholed, indicating that the replacement of flint by borax and feldspar caused the trouble.

In the area below *B-B* it was possible to vary the borax between 3.7% and 31.9% and feldspar between 11.2% and 39.4%, while keeping the flint constant, and still obtain a good enamel. These figures are a comparison of enamels 19 and 20.

Comparing enamels 10 and 17, it was found possible to vary flint between 22.5% and 37.5% and feldspar between the same limits without geting outside the good enamel area; *i.e.*, between these limits it was possible to replace flint by feldspar and vice versa.

Considering enamels 0 and 20, it was found possible to lower borax from 22.5 to 3.7%, meanwhile distributing its loss equally between flint and feldspar, without getting outside the good enamel area. (In actual practice an enamel should not be varied so widely unless it is done intentionally and with some definite purpose in mind.)

There are various other comparisons to be drawn, but these will suffice to show the possibilities of variation.

It was to be expected that the enamels below *A-A* would be acid re-

sistant, for they form the group lowest in fluxes. If this were the only reason for their resistance, No. 18 should fall within that area. The fact that it does not seems to indicate that high feldspar does not necessarily make an enamel acid resistant.

With the above enamels made up and studied, the following facts became apparent. (1) Enamels above and to the right of *B-B* were getting further

TABLE III

ENAMELS* MADE UP FOR PART II

Enamel	0	1a	2a	3a	4a	5a	6a	7a
Sb_2O_3	3.0	7.0	5.0	1.0		1.0	5.0	
Cryolite	10.0	8.0	12.0	14.0	11.5	8.0	6.0	7.0
Fluorspar	4.0	2.0		2.0	5.5	8.0	6.0	10.0

Enamel	8a	9a	10a	11a	12a	13a	14a	15a
Sb_2O_3	3.0	6.0	9.0	9.0		3.0	7.0	11.0
Cryolite	4.0	4.0	4.0	7.0	5.0	2.0	2.0	2.0
Fluorspar	10.0	7.0	4.0	1.0	12.0	12.0	8.0	4.0

Enamel	16a	17a	18a	19a	20a	High	Low	Range
Sb_2O_3	11.0			3.0	8.0	11.0	0.0	11.0
Cryolite	6.0	17.0	3.0			17.0	0.0	17.0
Fluorspar			14.0	14.0	9.0	14.0	0.0	14.0

Constants in each enamel formula

Feldspar	30.0
Borax	22.5
Flint	22.5
Na_2CO_3	5.0
$NaNO_3$	3.0

* See triaxial (Fig. 2).

away from the area of good compositions. (2) Enamels below and to the left were becoming refractory and harder to work. It was accordingly concluded that the good area was quite limited.

Part II

(A) Study of the Effects of Constituents Other Than Feldspar, Borax, and Flint

Having established the relations between feldspar, borax, and flint in their effects on sheet-iron cover enamels, it was desired to proceed a step further and study the relations of the other constituents.

Enamel No. 0 was the best of the Part I group. The triaxial (Fig. 1) shows that No. 0 lies just above line *A-A*, and just below line *B-B*. This indicated that it possessed the velvety luster of a soft enamel without the defect of pinholing and also that it was not extremely soluble. The actual appearance and behavior of No. 0 justified these conclusions.

It should be noted that No. 0 was the enamel that represented the aver-

TABLE IV

ENAMELS MADE UP FOR PART II AND THEIR PROPERTIES

Enamel	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12a	High	Low	Range	13a	14a	15a	16a	17a	18a	19a	20a
ENAMEL OXIDES (%)																							
KNaO	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8				13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
CaO	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Al_2O_3	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9				6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
B_2O_3	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6				9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
SiO_2	49.2	39.3	39.4	49.4	49.4	49.3	49.4	49.3	49.3	49.2	49.2	49.4				49.3	49.2	49.1	49.1	49.4	49.4	49.3	49.2
Sb_2O_5	8.7	6.2	1.3		1.3	6.2		3.7	7.4	11.1	11.1		13.5	0.0	13.5	3.7	8.7	13.5	13.5			3.7	9.8
CaF_2	2.3		2.3	6.5	9.4	7.0	11.7	11.7	8.2	4.7	1.2	14.1	16.4	0.0	16.4	14.1	9.4	4.7			16.4	16.4	10.5
Na_3AlF_6	9.4	14.0	16.4	13.5	9.4	7.0	8.2	4.7	4.7	4.7	8.2	5.9	20.0	0.0	20.0	2.3	2.3	2.3	7.0	20.0	3.5		
ENAMEL RATINGS																							
Surface	1	1	1	2	1	1	1	2	1	1	1	2				2	1	1	2	1	1	1	1
Opacity	1	1	1	3	1	1	3	3	1	1	1	2				2	2	3	3	1	2	2	1
Gloss	1	1	1	3	1	1	3	3	1	1	1	2				3	1	1	1	1	3	3	2
Acid resistance	3	3	3	3	3	3	2	3	2	2	2	3				3	2	2	1	3	3	3	2
Firing time	4	4	4	4	4	4	4	4	4	4	4	4				4	4	4	4	4	4	4	4
Firing temp. (°F)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1550				1500	1500	1500	1600	1500	1550	1550	1550
Faults*				sl. d.			sl. d.	d. p.				sl. d.				g.			g. Refr.				
Materials, cost of frit (¢. per lb.)	3.4	3.6	3.4	3.0	2.8	3.1	2.6	2.6	2.9	3.2	3.4	2.4	3.6	2.2	1.4	2.4	2.8	3.2	3.5	3.6	2.2	2.2	2.7
Smelting time	1:10	1:10	1:15	1:25	1:20	1:20	2:20	2:00	2:00	1:55	1:50	1:55	2:30	1:05	1:25	1:55	2:30	1:55	1:10	1:05	2:25	2:05	2:20
Temp. (°F)	2190	2090	2013	1980	2035	2015	2015	2150	2046	2140	2100	2100	2330	1980	350	2325	2330	2245	2190	2100	2110	2235	2235

* g., glassy; d., dull; p., pinholed; sl., slightly.

age of 12 enamels chosen from literature. This fact did not influence its selection; consequently, it can be cited as a proof that the average of a representative group of enamels is likely to be a good enamel.

(1) Choice of Variables The next question that arose was that of what constituents to vary in Part II. With feldspar, borax, and flint investigated there remained five others: namely, soda ash, soda niter, fluorspar, cryolite, and antimony oxide. A survey of the possibilities showed there were twenty-five possible combinations that might be investigated in two succeeding steps.

It was finally decided to hold feldspar, borax, flint, soda ash, and soda niter constant, while varying cryolite, fluorspar, and antimony oxide. These three were chosen because they are generally recognized as giving opacity in the frit.

Accordingly, a new triaxial diagram was prepared and cryolite, fluorspar, and antimony oxide placed at its apices. (See Fig. 2.)

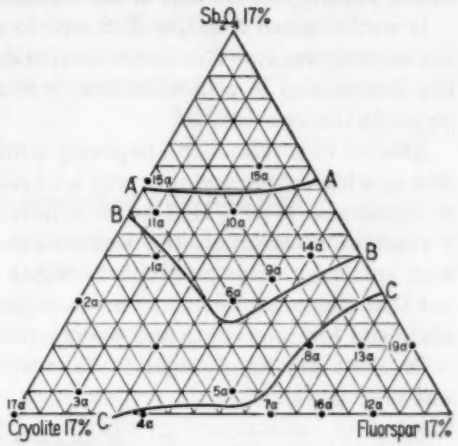

FIG. 2.—Above line *A-A*, enamels are refractory, glass, and of low opacity; above line *B-B*, enamels have good acid resistance; below line *C-C*, enamels are slightly dull and weak in opacity; between lines *A-A* and *C-C* is area of best enamels. Variation of cryolite, fluorspar, and antimony oxide (thesis problem, Part II):

Variables	17	Flint	22.5
Feldspar	30	Na_2CO_3	5
Borax	22.5	$NaNO_3$	3
			100.0

Since the sum of these three added up to 17% of the composition of enamel No. 0, the divisions of the triaxial were given such a value that any point on the diagram represented a total of 17% of cryolite, fluorspar, and antimony oxide. It was possible to vary any one of the three from 0 to 17%. An example is enamel 17a which contains 17% cryolite, but neither fluorspar nor antimony oxide.

Enamels were then made up as represented by points 1a to 20a on the triaxial diagram (Fig. 2).

(B) Discussion of Results

The area studied gave a large percentage of good enamels. A study of Fig. 2 and Table IV shows that enamels 15a and 16a, above line *A-A*, were weak in opacity. They were high in antimony oxide, no doubt too high.

Between lines *A-A* and *C-C* is a large area containing good enamels. Most of these enamels were extremely good. They possessed a soft creamy white color with high luster. There was a noticeable lack of faults. Their surfaces were smooth and flawless.

Below the line *C-C*, the enamels were slightly dull and lacking in opacity. They were all good enough to be classified as fair enamels, however.

Above the line *B-B* the enamels were fairly acid resistant. This is in the high antimony oxide area, but the acid resistance is no doubt partially due to the low fluorine content of the enamels.

It will be noted that line *B-B* dips to include enamels 6 and 9, but does not include No. 1. This seems to indicate that the presence of fluorspar is less detrimental to acid resistance than is cryolite. Work by J. B. Shaw supports this conclusion.[3]

Enamel 16 is refractory, requiring a firing temperature of 1600°F, but it fires to a high gloss, and it is very acid resistant. It was almost untouched by immersion in 20% HCl for 45 minutes.

It seems, according to the results as shown, that the corners representing high antimony oxide and high fluorspar do not produce the best enamels but that high acid resistance can be secured with enamels high in antimony oxide and low in cryolite and fluorspar.

On the other hand, enamel 17a, with no antimony oxide or fluorspar, was very good.

(C) Economic Features

(1) Choice of Formulas Although this investigation was limited in extent, it may serve to point out a number of advantages arising from such work.

If an enamel that is soft and fusible is desired, a consideration of the triaxial (Fig. 1) and Table II would point out enamels 0, 13, and 19 as filling the requirements. Enamels 17a, 2a, or 3a of Part II would also do very well.

If a harder, more acid-resistant enamel is desired, enamels 14, 17, 20, or 16a should be considered.

(2) Comparative Frit Costs Other things being equal, the cost of raw materials used in compounding a frit is a factor. Table IV shows that the cost of raw materials per pound of frit range from 2.2 to 3.9 cents. A consideration of comparative compositions, time and temperature of smelting, and quality of finished product is of interest. The enamel costing 2.2 cents per pound requires over two hours to smelt at a high temperature. The enamel requires 1550°F to fire properly. When finished, its gloss and opacity are rather second grade.

[3] J. B. Shaw, "Antimony Oxide as an Opacifier in Cast-Iron Enamels," *Jour. Amer. Ceram. Soc.*, **1**, 502–13 (1918).

On the other hand, the enamel costing 3.9 cents per pound of frit is so high in fluxes as to be of doubtful value, although it smelts and fires at a low temperature.

Between these outside limits there are other enamels that merit careful consideration. In the case of enamels 2a and 5a, the raw materials in one costs 3.6 cents per pound of frit, and in the other 2.8 cents. They smelt and fire at the same time and temperature. Both are very good enamels, yet a 100-pound bag of 2a frit costs 80 cents more than a 100-pound bag of 5a frit. This could total up to a very considerable sum in a plant where many thousand pounds of frit were being smelted daily.

This paper does not attempt to deal further with the economic features of the work. It merely offers them for consideration.

Part III

(A) Treatment of the Subject of Acid Resistance

Acid resistance is a property of primary importance in enamels for many uses; therefore, it was considered in this investigation.

On studying the appearances of enamels (attacked by acid) under a microscope, it is evident that many enamel surfaces are not dissolved away by the acid. The acid produces an appearance of very fine crazes, which fact leads to the theory that such enamels are attacked by acid due to the solution of only the material existing in fine cracks. One could theorize extensively on this phenomenon but such will be left for further research when it can be based on more complete data.

In experimenting with these enamels it was discovered that an enamel treated with acid which destroyed its gloss could be returned to its original gloss by refiring. It was further discovered that the second gloss was very much more acid resistant than the first. In some cases it was almost acid proof, withstanding boiling 10% sulphuric acid.

(B) Preliminary Work

A great deal of preliminary work was done on the effect of time in the acid bath, time of refiring, temperature of refiring, and the relative effects of various acids.

Finally, a systematic series of tests were run on all of the 36 enamels that had been made up. This work is summarized in Table V.

(C) Laboratory Methods

To expedite the work, a standard treatment was applied to all enamels. One end of each piece was immersed in cold 20% hydrochloric acid for five minutes, washed, dried, and each piece refired with 50° increase in temperature and 50% increase in firing time.

Relative return of gloss was noted, after which each piece was re-immersed in 20% HCl, but one-half inch deeper than before, and left for 45 minutes. They were then removed, washed, dried, and examined. Each piece had one end that had been re-glossed, and again subjected to acid,

TABLE V

ACID* TREATMENT AND REFIRING TO RESTORE GLOSS

Enamel	1st T	1st T°	2nd T	2nd T°	Minutes in acid	Gloss return**	Min. in 2nd acid bath	Gloss condition†
0	4	1500	6	1550	5	1	45	1
7	4	1500	6	1550	5	2	45	3
8	4	1550	6	1600	5	2	45	2
9	4	1600	6	1650	5	1	45	3
10	4	1500	6	1550	5	1	45	1
11	4	1500	6	1550	5	2	45	3
12	4	1500	6	1550	5	3	45	3
13	4	1500	6	1550	5	1	45	3
14	4	1500	6	1550	5	1	45	1
15	4	1500	6	1550	5	3	45	3
16	4	1500	6	1550	5	3	45	3
17	4	1550	6	1600	5	1	45	1
18	4	1550	6	1600	5	1	45	2
19	4	1500	6	1550	5	2	45	3
20	4	1550	6	1600	5	1	45	1
21	4	1500	6	1550	5	3	45	3
1a	4	1500	6	1550	5	1	45	1
2a	4	1500	6	1550	5	1	45	1
3a	4	1500	6	1550	5	2	45	3
4a	4	1500	6	1550	5	3	45	3
5a	4	1500	6	1550	5	1	45	2
6a	4	1500	6	1550	5	1	45	1
7a	4	1500	6	1550	5	3	45	3
8a	4	1550	6	1600	5	1	45	3
9a	4	1500	6	1550	5	1	45	1
10a	4	1500	6	1550	5	1	45	1
11a	4	1500	6	1550	5	1	45	1
12a	4	1550	6	1600	5	2	45	3
13a	4	1500	6	1550	5	3	45	2
14a	4	1500	6	1550	5	1	45	1
15a	4	1500	6	1550	5	1	45	1
16a	4	1600	6	1650	5	1	45	1
17a	4	1600	6	1550	5	2	45	3
18a	4	1550	6	1600	5	3	45	2
19a	4	1550	6	1600	5	3	45	2
20a	4	1550	6	1600	5	1	45	1

* 20% HCl used.

** Gloss return
1, excellent
2, good
3, fair
4, poor

† Gloss condition
1, as good as original
2, serviceable surface
3, poor surface

a one-half inch strip in the middle that showed the effect of acid on the original surface, and one end that had not been subjected to acid at all.

In this way it was possible to obtain the results that have been listed in the tables.

(D) Discussion of Results

It should be noted that in a blanket test of this kind some of the enamels were subjected to the first acid bath for too long a time, some were refired at either too high a temperature, or for too long a time. Nevertheless, fifteen of the thirty-six came through very well. It is possible that every one that was a good enamel to begin with could have been brought through satisfactorily with proper treatment.

An enamel that pinholes is not adapted to this treatment. The area immediately around the pinholes sometimes shows acid attack after refiring. This may be due to the acid's reaching the metal, or to its working under the surface around the hole.

It was noted that some pieces with no ground coat on the back side chipped with a snapping sound while being subjected to the second acid bath. The same enamels, when applied to pieces previously enameled in ground coat on both sides, came through perfectly.

The chipping apparently was due to the action of the acid on the base metal. As the metal was eaten away, stresses seemed to be set up that either were not present before, or else were in a state of equilibrium with other forces in the enamel.

(E) Conclusions

(1) Many enamels can be made acid resistant by proper treatment.

(2) The proper time of acid treatment varies with each enamel composition.

(3) An enamel should be left in the acid bath only long enough to take off the high luster. At least a faint light reflection should be visible on the surface. When an enamel is attacked so severely that the surface is quite dull and is capable of being scratched with the finger nail, it will not refire to a gloss. This applies to soft enamels very sensitive to acid attack.

(4) Enamels that are originally quite acid resistant are not subject to the restrictions of conclusion 3. A prolonged stay in the acid bath does not harm them since some luster persists.

(5) Refiring time and temperature should be increased; (50° increase in temperature and a 25–50% increase in time are suggested). This seems to be necessary because some of the fusible (and soluble) fluxes are removed in the acid bath.

(6) Soft enamels, with their high gloss and beautiful texture, and harder enamels with original acid-resistant qualities show equal acid resistance after proper treatment.

(7) The acid used is not a factor; 10% H_2SO_4, 20% HCl, and 10% citric acid all gave equal results.

(8) This method of making an enamel acid resistant seems to be worthy of use in several lines of production. Among others might be suggested chemical enameled ware and special orders requiring acid-resistant enamel. Its use requires no special frit with its resulting separate milling and storage.

The regular plant enamel that works well and has all the desired opacity,

texture, and luster will continue to have these properties and in many cases the added one of high acid resistance, when correct treatment is used.

II. General Summary

The results of the investigation may be summarized and conclusions drawn as follows:

(1) It is often possible to obtain a good enamel by taking the averages of ingredients found in a representative group of enamels.

(2) By a systematic variation of the materials used in such an enamel, it is possible to obtain derived enamels of widely varying properties.

(3) These properties may be definitely associated with the position of the enamel on a triaxial diagram.

(4) Any enamel may be investigated by means of the triaxial diagram. By its use the investigator guards against the mistake of repetition. It is evident that in many cases a considerable variation in raw materials causes little or no change in enamel properties.

(5) Once an enamel formula is expanded, the enamel maker, knowing the properties needed in an enamel, is enabled to choose the correct area in which to carry out his investigations.

(6) It was possible to obtain good enamels within wide limits of variation of cryolite, fluorspar, and antimony oxide.

(7) The combination of high antimony and low fluorides produced enamels of increased acid resistance.

(8) The presence of fluorspar is less detrimental to acid resistance than is that of cryolite.

(9) High fluorspar enamels were somewhat dull.

(10) Firing temperature did not affect acid resistance provided it was held within the correct range.

(11) Enamels low in cryolite or high in flint and feldspar were hard to smelt. Fusion was slow and the melt was viscous. Once properly smelted the resulting frits were not exceptionally difficult to fuse on the metal.

(12) The acid bath treatment to produce acid-resistant enamels can be applied to either hard or soft enamels. More care is required when the enamel is soft.

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CERAMIC ABSTRACTS[1]

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Abrasives

Abrasives. J. B. Glaze. *Tech. Eng. News*, **7**, 175–77 (1926); *Eng. Index*, 1926.—The development of artificial abrasives, early and modern uses, and manufacture are discussed. (*J.I.M.*)

Incorrect abrasives are expensive. Jeremiah Muldoon. *Abrasive Ind.*, **12** [6], 27 (1931).—M. describes attempts to use an incorrect abrasive for precision work. The expense of correct abrasives would more than have compensated for the time and wastage. E.P.R.

Abrasives in production grinding. B. H. Work. *Machinery* [N. Y.], **35**, 535 (1929).—A note on a paper read by W. before the Society of Automotive Engineers, Detroit. (*J.I.M.*)

Abrasive cut-off wheel is developed. Hunter Saw & Machine Co. *Abrasive Ind.*, **12** [6], 35 (1931).—This wheel makes it possible to cut solid metal up to 2 in. in diameter on the machine ordinarily used for cutting light sections, angles, and pipe by means of a saw. These abrasive wheels are 16 in. in diameter and replace the standard 18-in. saw. E.P.R.

Abrasive operations at Cadillac Motor Car Co. Fred B. Jacobs. *Abrasive Ind.*, **12** [6], 16–20 (1931). E.P.R.

Carborundum. F. W. Higgins. *Trans. Manchester Assn. Eng.*, 98–125 (1925–26).—After a description of the discovery, manufacture, and properties of carborundum, details are given of its application to the grinding of metals, particularly those of low tensile strength, for which it is far superior to emery. G. E. Windeler, in the discussion, states that carborundum is especially suitable for grinding aluminum, and is particularly adapted to the finish-grinding of aluminum pistons. (*J.I.M.*)

Accuracy in wheel truing and mounting. Anon. *Abrasive Ind.*, **12** [6], 21–23 (1931).—A precision grinding wheel is a disk mounted in a rigid machine and operating at a surface speed from 5000 to 10,000 ft./min. Wheels 30 in. in diameter and larger are in everyday use on precision machines. This article illustrates and describes briefly the methods followed in this important procedure at the Hupp Motor Co. E.P.R.

Wheel control in grinding. Anon. *Abrasive Ind.*, **12** [6], 26–27 (1931).—The wheel which combines the correct abrasive, bond, grit size, hardness, and density can be selected for a given job. Even the best wheel for the job, however, will yield poor results if the fundamentals of wheel operation are forgotten. The cutting teeth of a grinding wheel revolve against the work, each tooth taking its share of the cut. Such a large

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
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number of teeth mounted so close together introduces the problem of getting rid of the chip after it has been cut. The wheel is said to be loaded when the grinding dust or chips formed remain embedded between the cutting points and in the pores of the wheel. A softer grade wheel will stop the loading. Another hindrance to successful grinding is glazing of the cutting surface of the wheel. Glazing often is confused with loading because the cutting action of the wheel is affected similarly by both. Heating and slow cutting are the results. Glazing is the inevitable result of using a wheel of too hard a grade. Lower wheel speed and faster work speed act to decrease wheel glazing. Even with the best wheel for a given cutting job a certain amount of glazing or loading or both may occur. Frequent use of the wheel-dressing tool or the diamond will remove the dulled and loaded grains and present a free-cutting surface. The dressing tools and methods of their use are described. The terms, dressing and truing, sometimes are used interchangeably, but they denote two separate operations. Dressing helps to make the wheel free-cutting by removing glazed or loaded surfaces. Truing corrects the wheel face for greater accuracy. Another obstacle to efficient grinding is vibration. Any rotating body which is not exactly balanced will vibrate. Vibration causes several difficulties, *e.g.*, chatter marks on the work and rapid wheel wear. The balance may be restored in several ways. Improper work drive and mounting are other causes of vibration. E.P.R.

Setting up wheels rapidly. A. KENDALL. *Abrasive Ind.*, **12** [6], 42 (1931).—The device applies abrasive to the glue-coated wheel in a quick and efficient way. Illustrated. E.P.R.

Grinding formed cutters accurately. HECTOR J. CHAMBERLAND. *Abrasive Ind.*, **12** [6], 20 (1931).—The equipment is designed to handle index grinding operations in a small shop where no machine is available to do such work accurately. C. used this means to correct errors of distortion on several machine parts due to hardening. He discovered that by the simple addition of a post to hold a diamond, the equipment could be made to duplicate an expensive formed cutter grinding machine. The method is described in detail. The diamond automatically keeps the cutting edge of the wheel on center at all times, permits a fresh dressing for each flute, and guarantees a perfect concentric, radial, and straight job on any formed cutter or hob provided with straight flutes. Illustrated. E.P.R.

Grinding thin copper disks. H. TAYLOR. *Amer. Machinist* [Eur. Ed.], **73**, 102–103*E* (1930).—A description is given of a pneumatic chuck for grinding thin copper disks. The chuck acts for nonferrous sheets in the same manner as a magnetic chuck acts for ferrous metals. It is fitted with a number of annular grooves in which are drilled equally spaced holes through which the grooves may be evacuated. A pressure of 3 lb./sq. in. at the pump gives a pressure of about 70 lb. between the work and the table in the case of copper disks for gramophone work. (*J.I.M.*)

Production gear grinding machine has hydraulic drive. PRATT & WHITNEY CO. *Abrasive Ind.*, **12** [6], 33–34 (1931).—The operating principle is simple, wherein a reciprocating horizontal ram carries the grinding wheel back and forth through the teeth, generating the adjacent sides of two teeth simultaneously. Illustrated. E.P.R.

Grinder for tungsten-carbide tools. U. S. ELECTRICAL TOOL CO. *Abrasive Ind.*, **12** [6], 35 (1931); for abstract see *Ceram. Abs.*, **10** [7], 470 (1931). E.P.R.

To grind a 200-in. quartz mirror. ANON. *Abrasive Ind.*, **12** [6], 25 (1931).—One of the largest precision grinding operations ever attempted is graphically illustrated. See also *Ceram. Abs.*, **10** [7], 490 (1931). E.P.R.

Studies in metal polishing. II. EDWIN M. BAKER AND GEORGE E. HOLBROOK. *Metal Cleaning & Finishing*, **3** [5], 385–88 (1931); *Abrasive Ind.*, **12** [6], 38–41 (1931).—The effect of grain sizing on the depth of scratches, methods of testing glue, and the

effect of soaking glue upon its viscosity are discussed. Illustrated. For Part I see *Ceram. Abs.*, **10** [7], 471 (1931). E.J.V.

Automatic polishing and buffing machine. HAMMOND MACHINERY BUILDERS, INC. *Metal Cleaning & Finishing*, **3** [5], 435–36 (1931).—A description of the features of a new universal automatic polishing and buffing machine is presented. Illustrated. E.J.V.

Grit structure of the polishing wheel. HENRY R. POWER. *Metal Cleaning & Finishing*, **3** [5], 427–28 (1931).—Abrasive grains should be angular in order to increase their surface tenacity which in turn allows the grains to pack into a more efficient cutting surface on the periphery of the wheel. Other properties of abrasives are pointed out. Illustrated. E.J.V.

Buffing lathe. HISEY-WOLF MACHINE CO. *Abrasive Ind.*, **12** [6], 37 (1931); for abstract see *Ceram. Abs.*, **10** [6], 400 (1931). E.P.R.

Buffing irregular shapes automatically. CONTOUR BUFFING MACHINE CO., INC. *Abrasive Ind.*, **12** [6], 41–42 (1931); for abstract see *Ceram. Abs.*, **10** [6], 401 (1931). E.P.R.

Lap gears accurately. NATIONAL BROACH & MACHINE CO. *Abrasive Ind.*, **12** [6], 34 (1931).—This machine is driven by a motor mounted on the back of the column. The drive is through gear reduction to a horizontal shaft carrying the lap which, by its rotation, drives the gear which is mounted between centers in process of lapping. Illustrated. E.P.R.

Machine for control ease. HANCHETT MFG. CO. *Abrasive Ind.*, **12** [6], 36 (1931).—The tool is a hydraulically operated face grinder entirely self contained. The work table or platen is operated hydraulically, thereby eliminating the customary rack and gear drive as well as supplying all of the advantages of the hydraulic drive. Table speeds from 0 to 90 ft./min. are the standard range but can be increased to 160 ft./min. Illustrated. E.P.R.

Fully enclosed coolant pump. RUTHMAN MACHINERY CO. *Abrasive Ind.*, **12** [6], 35 (1931).—The device is a vertical grinding-machine pump having a capacity of 120 gal./min. for continuous operation. Illustrated. E.P.R.

Automatic dust-exhausting system. HISEY-WOLF MACHINE CO. *Abrasive Ind.*, **12** [6], 37 (1931).—A dust-exhausting equipment consists of a vertically mounted ball-bearing motor and fan located on the back of a buffing lathe with an exhaust duct running to each hood. Illustrated. E.P.R.

Automatic sizing as time saver. ANON. *Abrasive Ind.*, **12** [6], 35–36 (1931).—By use of automatic sizing devices, it is now possible to grind cylindrical work on centerless grinders without the necessity of frequently checking the parts for accuracy or adjusting the feed wheel slide. E.P.R.

German equipment designed for honing cylinder bores. S. WEIL. *Abrasive Ind.*, **12** [6], 24–25 (1931).—Excessive wear on piston rings is overcome and the time required to run in internal combustion engines is lessened when the cylinders are honed smoothly and exactly by the use of rotating and adjustable tools with a quick up and down stroke. The cylinders are bored straight and cylindrical, and between 0.0015 in. and 0.0025 in. on the diameter is left for honing. E.P.R.

International standardization of grain and hardness of grinding wheels. W. GLODDE. *Maschinenbau*, **5**, 317–18 (1926); *Eng. Index*, 1926.—The connection between grain standards of the German abrasives industry and N.D.I. screen standards, and the recommendation of the international conference to examine grain standards for adoption in the U.S. are discussed. International standards for degrees of hardness of grinding wheels are proposed. (*J.I.M.*)

BOOKLETS

Causes of cracks. ANON. *Abrasive Ind.*, **12** [6], 31 (1931).—Causes and corrections of cracks sometimes found in the ground surfaces of hardened steels are discussed in a booklet recently issued by Norton Co. Results of the experiments show that the cracks may be caused by abusive heat treatment, abusive grinding, or by a combination of the two conditions. E.P.R.

Issue lapping data. ANON. *Abrasive Ind.*, **12** [6], 42 (1931).—An illustrated booklet devoted to commercial lapping has been issued by Norton Co. The most important fields for lapping are found in the automotive industry. The advantages of lapping processes to secure accuracy and a high finish are explained. E.P.R.

PATENTS

Grinding. GEORGE W. BINNS. U. S. 18,103, June 16, 1931 (reissue). A centerless grinder including opposed grinding and regulating wheels, the grinding wheel having portions adapted to produce cylindrical and noncylindrical portions on a work piece, and a regulating wheel having a work-controlling portion engaging and urging a cylindrically shaped portion of the work piece toward the grinding wheel whereby the work is reduced to a contoured form contrageometric to that imposed on the surface of the grinding wheel and is controlled in its rotation by the engagement of the regulating wheel with the cylindrical portion thereof.

Emery wheel dressing tool. CONSTANT DE MATTIA. U. S. 1,805,514, May 19, 1931. A device comprising a plurality of annular disks having V-shaped peripheral teeth, means for securing the disks together to form a unit with the teeth of the respective disks in staggered relation, a supporting arbor revolvable with the cutting disk, a pair of sleeves fitted with antifriction bearings in which the arbor is journaled, an arm having a yoke-shaped end with tapering screw-threaded split hubs to receive and grip the sleeves, and caps having tapering tapped screw-threaded flanges engaging the hubs, whereby upon adjustment of the caps the hubs may be compressed to grip and hold the sleeves against rotation.

Grinding wheel testing apparatus. HERMON G. WEINLAND. U. S. 1,805,896, May 19, 1931. In a testing machine for grinding wheels, a grinding wheel mounting including a shaft for the wheel, an air motor having a shaft aligned with the wheel shaft, a flexible connection between the shafts, a speed-indicating instrument having a shaft aligned with the motor shaft, and spring means for holding it in uniform frictional engagement with the motor shaft.

Abrasive wheel. THURE LARSSON. U. S. 1,805,949, May 19, 1931. A segmental grinding wheel comprising a plurality of abrasive segments arranged in the form of an annulus, the annulus having on each of its opposite sides two opposed beveled clamping shoulders sloping in opposite directions and forming a wedge-shaped clamping lug, a clamping plate on each side of the annulus provided with beveled faces corresponding with the clamping shoulders on the annulus, and means to draw the plates together, the parts being so arranged that the annulus is supported wholly by its beveled clamping shoulders.

Dressing abrasive laps. SYDNEY PLAYER. U. S. 1,805,955, May 19, 1931. Apparatus for dressing the opposed faces of the lapping elements in a lapping machine having two abrasive laps and a work cage revolvable therebetween which has a plurality of work-receiving openings adapted to hold work pieces in lapping contact with the laps comprising several small cutting tools shaped and sized to fit loosely in and project through the openings in the work cage and having cutting faces on its opposite sides capable of cutting the abrasive surfaces of both laps when revolved in contact therewith.

Grinding the rolls of ore-crushing or like mills. AUGUST VOEGEL. U. S. 1,806,226,

May 19, 1931. The combination with a rotary grinding tool arranged at right angles to the roll under treatment so that the front face of the tool is presented to the roll, of means for revolving the latter, spring-actuated means for resiliently keeping in contact the grinding tool with the roll under treatment, a screw and nut drive adapted to move the grinding tool along the roll under treatment parallel to its axis, and of feeding means coöperatively associated with the roll under treatment and with the screw and nut drive so as to periodically actuate the latter.

Grinding machine. ALBERT G. BELDEN AND CHARLES G. TREFETHEN. U. S. 1,806,664, May 26, 1931. A cylindrical grinding machine comprising a base, a rotatable grinding wheel, and a work support which are movable relatively toward and from each other, a cross-feed screw and nut connected to cause such movement, a power-actuated mechanism including a cam and a follower operatively connected to rotate the feed screw in both directions through a predetermined angular distance and at a varying rate, and means operated in timed relation with the power-actuated mechanism to stop the mechanism after the grinding wheel has finished its cutting operation.

Method of making a segmental grinding wheel. HUGO W. H. BETH. U. S. 1,806,665, May 26, 1931. (1) The method of making a grinding wheel having abrasive segments adjustably clamped on a rotatable support comprising the steps of locating the segments in an approximately correct grinding position on the support, providing a layer beneath the segments of a moldable material capable of setting to a hard body, forcing the material into full contact with the adjacent faces of the segment and the support, permitting the moldable material to harden in place, and thereafter drawing the segments down firmly onto the support. (2) A grinding wheel comprising a rotatable support, a plurality of abrasive segments thereon, each segment having spaced locating shoes of compressible material thereon and a shoe molded to that portion of the support beneath on which it rests, and means for clamping the segments securely on the support.

Grinding machine. CLEMENT BOOTH. U. S. 1,806,886, May 26, 1931. In a grinding machine, in combination, a pair of abrasive wheels, means for rotating both of the wheels, means for supporting work therebetween for action thereon by the wheels, and means actuated by fluid pressure for moving one of the wheels toward and into predetermined spaced relation to the other, and then away from the other to respectively grip and release the work.

Thread grinding machine. HENRY E. DURKEE. U. S. 1,807,516, May 26, 1931. A thread grinding machine comprising in combination, a base, an abrasive wheel mounted thereon, a reciprocatory table, a work-supporting and rotating spindle on the table, means to rotate the spindle, connections between the means and the table whereby the table is moved past the wheel in timed relation to the rotation of the spindle, and axially movable means within the driving connections to vary the amount of lost motion between the rotating means and the spindle.

Grinding rolls. OSKAR WALDRICH. U. S. 1,808,392, June 2, 1931. Apparatus for setting rolls including a bearing, a pair of bearing blocks mounted in the bearing and adjustable in such mounting along lines of direction angularly disposed one to the other, gaging means including an arm rotatably mounted on the bearing, a gage bolt extensibly mounted on the arm, and a second gage bolt mounted on the bearing and extensible along a line which is transverse with respect to the line of extension of the first-named bolt.

Grinding machine. JOHN COOK, JOHN C. SPENCE, AND RAYMOND A. COLE. U. S. 1,808,401, June 2, 1931. A grinding machine comprising a work support, a wheel slide mounted for feeding movement toward the work, a grinding wheel thereon, a rotatable, axially movable spindle to support the grinding wheel, manually operable

means to move the spindle axially to locate the grinding wheel in a predetermined grinding position, and automatically operated mechanism to move the spindle axially in the opposite direction to remove the grinding wheel from the grinding position.

Grinding and polishing lathe. RAYMOND C. MITCHELL. U. S. 1,808,728, June 2, 1931. In a construction of the character described, a hollow supporting pedestal, a shelf mounted in the lower portion of the pedestal for oscillatory movement in a vertical direction, means for securing the oscillatory shelf in different positions of swinging adjustment, a motor mounted upon the shelf within the hollow pedestal, a spindle located at the top of the pedestal, drive and driven pulleys carried by the motor and spindle respectively, a belt having therein excessive slack connecting the driving and driven pulleys, automatic belt-tightener means for taking up the slack of the belt, an operating lever located exteriorly of the pedestal and connected with the belt-tightener means for retracting the belt tightener and relaxing the driving tension of the belt, and a detent extending into the path of movement of the lever for engaging and holding the lever in retracted position.

Valve grinder. FRED W. MILLER. U. S. 1,808,856, June 9, 1931. A valve grinder comprising a brace having a slot in the shank thereof, a central bit having a series of longitudinally arranged holes therein, means for securing the bit in the slot, and side bits having series of longitudinal projections adapted to engage with the holes, the side bits being held in engagement with the center bit by the sides of the slot.

Grinding or abrading wheels. K. DRAPAK. Brit. 347,038, April 29, 1931.

Grinding or abrading machines. W. W. TRIGGS. Brit. 348,180, May 20, 1931.

Abrasives. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Ger. 521,124, June 17, 1928; for abstract see *Ceram. Abs.*, **7** [11], 736 (1928). (*C.A.*)

Art and Archaeology

Experiments with marl clay. G. JAKO. *Keram. Rund.*, **39**, 79–82 (1931).—Clays containing considerable $CaCO_3$ (23 to 35%) have the advantage of giving beautiful yellow colors after firing, low firing temperature, and the ability to carry colored majolica glazes well. The following precautions must be observed: (1) $CaCO_3$ must be finely divided to avoid popping during firing. (2) Lime added to clay must be in the softer forms, *e.g.*, chalk or marl. (3) Gradual heating above redness and gradual cooling are essential since the body is not especially resistant to heat shock. (4) Prefired grog assists in resistance to thermal shock. (5) NaCl as glaze material must be avoided. (6) Alkalis and boron compounds in the glaze must be thoroughly fritted and combined with the silicates. (7) The firing temperature must not be less than cone 01. H.I.

Test methods for acid-resisting enamel colors. EISENLOHR. *Keram. Rund.*, **39**, 9–10 (1931).—The stability of enamel colors is most safely and quickly tested with 3% HCl. Many samples which appear to be acid-proof when using 4% acetic acid, fail in the HCl test. All samples which withstand the HCl test are able to withstand alkaline solutions in the concentration usually used in practice. H.I.

Vermillion glazes with uranium. ARNULF HOLL. *Keramos*, **10** [5–6], 143–44 (1931).—H. describes investigations made to obtain a vermillion color in enamels with uranium compounds. The vermillion color on fired and unfired glazes is obtained at 900 to 1100°. The chemical composition of such a glaze is

$$\left.\begin{matrix}0.40\ PbO\\0.07\ K_2O\\0.53\ ZnO\end{matrix}\right\}\ 0.07\ Al_2O_3\ \left\{\begin{matrix}0.90\ SiO_2\\0.90\ SnO\end{matrix}\right.$$

Such glazes and colors can be fired in every kiln with an oxidized atmosphere. M.V.K.

Enameling glassware. F. SKAUPY. *Ind. Silicati*, **9** [1], 10–11 (1931).—Enamels used for coating glassware and directions for their application are discussed. M.V.K.

Preparation of colloidal glass colors. W. HANNICH. *Glas & Keram. Ind.*, **8**, 5 (1930).—While colloidal glass colors are now in common use, little is known about their actual manufacture. Directions are given for the manufacture of colloidal solutions of platinum, palladium, and iron oxide, together with a description of the resultant particles in regard to their varying size and color. A starch solution shows no well-defined movement of its particles such as may be seen in other colloids. Their size is extremely varied and consequently starch paste cannot be recommended as a carrying medium for colors. (*J.S.G.T.*)

Glazing practice of an art ceramics factory. W. HENZE. *Keram. Rund.*, **39**, 17–19 (1931).—More than 20 glaze formulas are given for brilliant, mat, crystal, and luster glazes in various colors. In Holland mat glazes are produced by introducing large quantities of water vapor into the kiln at the conclusion of the fire and sealing the kiln tightly. The matness is produced without making the glaze entirely opaque. H.I.

Painting porcelain. ANON. *Sprechsaal*, **64** [12], 238 (1931).—A new method for painting porcelain has been discovered in Prague by R. H. Schlidenbuch, called by him "Effacure." The painting is not done with a brush but with special patented tools. The method simplifies and increases the speed of working. M.V.K.

Secret glue and sandblast etch glass and stone. ANON. *Popular Sci.*, **119** [1], 69 (1931).—By sandblasting a design which has been cut in a glue coating on the object that is to be etched, the desired effect is obtained. Illustrated. E.J.V.

Artist tours the potteries. III. ANON. *Pottery Gas.*, **56** [648], 855 (1931).—In this instalment sketches and descriptions of mold-making and painting by brush are presented. For Part II see *Ceram. Abs.*, **10** [7], 477 (1931). E.J.V.

Need of ceramic research in industrial applied art. THEO. LENCHNER. *Ceram. Ind.*, **16** [6], 547–48 (1931).—It is suggested that manufacturers back the idea of an American School of Ceramic Design, choosing students based in engineering, ceramic technology, and art, with a view to creating good American designs adaptable to mass production. W.W.M.

University of commercial art. EDITH SUSCHITZKY. *Commercial Art*, pp. 113–14 (March, 1931).—The Bauhaus, school of architecture and crafts, is a university of commercial art at Dessau, Germany. The aim is to "simplify, standardize, and cheapen all objects for practical use from the house down to the teaspoon to make living easier." (*D.I.*)

Importance of style and design in industry. ANON. *Commercial America*, pp. 33–34 (April, 1931).—Styling may increase or decrease profits. Methods of the Gorham Company and W. & J. Sloane have been notably successful. (*D.I.*)

New lines in china and glass. ANON. *Pottery, Glass & Brass Salesman*, **43** [6], 12 (1931).—Full descriptions are given of pottery and glassware exhibited by the following companies: (1) The Continental Ceramics Corp., (2) Louie & Weston Glass Co., (3) Percy & Leyland, Inc. *Ibid.*, **43** [7], 12 (1931).—(1) Cataract-Sharpe Mfg. Co., (2) Sloan Bros., (3) Haruta & Co., (4) Paul A. Straub & Co., (5) McKenna Bros. *Ibid.*, **43** [8], 12 (1931).—(1) Lazarus & Rosenfeld, (2) Otto Goetz, Inc., (3) Maddock & Miller, (4) Edmondson Warrin, Inc., (5) Morgantown Glass Works. *Ibid.*, **43** [9], 12 (1931).—(1) Frederick Skelton, (2) Rowland & Marsellus Co., (3) Corning Glass Works. *Ibid.*, **43** [10], 12 (1931).—(1) J. H. Venon, Inc., (2) Fulper Pottery, (3) A. H. Heisey & Co. E.P.R.

Ceramic and glass arts in France. ANON. *Sprechsaal*, **64** [9], 169; [17], 319 (1931).—The latest French achievements in the ceramic and glass arts are discussed. M.V.K.

Two examples of modern packaging. ANON. *Canning Age*, p. 318 (April, 1931); *Canner*, pp. 30–32 (March 28, 1931).—The catsup bottle and rose jars for jellies are described. (*D.I.*)

Mayan and Indian designs. ANON. *Gift & Art Shop*, p. 86 (April, 1931).—Mayan and Indian motives are growing in importance in jewelry, needlework, and textiles. (*D.I.*)

Decoration of glass. B. MAUDER. *Glashütte*, **60**, 820 (1930); for abstract see *Ceram. Abs.*, **8** [11], 790 (1929). (*J.S.G.T.*)

Early American pottery. A. R. R. *Christian Sci. Mon.*, **23** [145], 11 (1931).—The reddish-brown pie plates of the early settlers in Pennsylvania represent some of the earliest pottery made by white men in America. The earthenware was made from clays which were red, brown, or buff after firing. A glaze consisting of lead mixed with fine clay was used. Slip decoration was applied with a quill. Graffito decoration might be called pottery etching as the process is to cover the surface with a thin coating of slip of a lighter color than the body and then scratch it off with a pointed instrument, bringing out the darker color beneath. E.J.V.

Pottery at the Royal Academy. ANON. *Pottery Gaz.*, **56** [648], 807 (1931).—Some of the exhibits of examples of ceramic art and paintings dealing with ceramic processes or products are described. Illustrated. E.J.V.

Blue-dash chargers. COLLECTOR. *Christian Sci. Mon.*, **23** [145], 11 (1931).—A blue-dash charger is a large circular earthenware dish of from 12 to 18 in. in diameter. Flat dabs or dashes of blue surround the rims of most of them, hence the term "blue dash." Nearly all these chargers contain a pictorial reference to the late Stuart kings. The chargers are somewhat crudely decorated in blue, green, yellow, and purplish-brown, shining on the front with a thick, white, and frequently irridescent glaze. On the back there is a green or yellowish glaze. Fewer than 150 of these heirlooms are said to be in existence. Some of the better known specimens are described. Illustrated. E.J.V.

Faience of early France as forerunner of modern pottery. HELEN ROBERTSON. *Cleveland Plain Dealer*, Vol. 90, No. 144 (1931).—Faience is practically the same as earthenware, the only difference being that the former is always glazed, while earthenware is not. The early history of faience is traced. Outgrowths of faience ware are Italian majolica, the Deruta ware, Quimper pottery, Capri vases, "Italian pottery," etc. Brief histories of each of these types of pottery are given. Illustrated. E.J.V.

Ancient ware. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **23** [156], 11 (1931).—An exhibit of earthenware in various forms, made in Persia and in the countries between it and the Mediterranean Sea from the year 100 to 1800, is described. The types of decoration and design on exhibit are discussed, including enameled brick, luster ware, etc. The influences of the various racial achievements can be traced in the types of products and design. Some of the decorative motifs are described. Illustrated. E.J.V.

Greek evidences in the Balkans. STANLEY CASSON. *Discovery*, **12**, 108–12 (1931).—The graves discovered by the Bulgarian army while road-making in the World War have now been investigated by Jugoslavia, to whom the Lake Ochrida region was allocated after the war. The tombs prove to contain the richest Greek remains found so far north. H.H.S.

Art of glassmaking in medieval Italy. F. URBANI DE GHELTOF. *Ind. Silicati*, 9 [2], 10–12 (1931).—In all times and countries glassmaking was called the "noble art," and glassmakers were accorded special privileges not far removed from those of the nobility in Italian towns of the Middle Ages. See also *Ceram. Abs.*, 9 [12], 1010 (1930). M.V.K.

Terra cotta fingers and toes. SELIM HASSAN. *Illus. London News*, **178**, 295–97

(1931).—The tomb of a young woman of the 4th dynasty of Egypt has revealed terra cotta fingers and toes as a substitute for those of the body should they decay. Such objects have never before been discovered. H.H.S.

Brangwyn ware. ANON. *Art in Australia*, 3 [36], 52–53 (1931).—An appreciation is given of the Doulton domestic ware designed by Frank Brangwyn. Plate illustration. H.H.S.

Arnold Krog. ANON. *Connoisseur*, **87**, 199 (1931).—A recognition is given of the part played by K., who joined the Royal Copenhagen porcelain factory in 1885 and celebrated his 75th birthday on March 17, in creating the popularity of Copenhagen ware. H.H.S.

Thornton Wills collection of tobacco pipes. C. A. EDINGS. *Connoisseur*, **87**, 230–37 (1931).—Twenty-two photographs are given of pipes, some of very intricate pattern, made mostly in Staffordshire. H.H.S.

BOOKS

Höchst Porcelain. (German.) KURT RODER. With appendix on marks by Michael Oppenheim. 135 plates. L. Wilckers, Mayence, 1931. 70 Rm. Reviewed in *Connoisseur*, **87**, 253–54 (1931).—The Höchst factory began in 1746, first making rococo faience and then, in 1750, porcelain. Melchior came to the factory in 1768. H.H.S.

Atelier. Published by W. E. RUDGE, New York. 75¢ monthly; $7.50 post free per annum. This American edition of the *London Studio* commenced with the April, 1931, issue. H.H.S.

PATENTS

Design for jar. EDWIN W. FUERST. U. S. 84,333, June 9, 1931.

Design for lighting fixture bowl, etc. NICHOLAS KOPP. U. S. 84,351, June 9, 1931.

Design for tumbler, etc. WILLIAM W. REESE. U. S. 84,440, June 16, 1931.

Design for bottle. WILLIAM A. DOLAN. U. S. 84,234, May 26, 1931; ROBERT P. RICHARDSON. U. S. 84,258, May 26, 1931; WILLARD P. ZIMMERMAN. U. S. 84,313, June 2, 1931; ELI BECKER AND ISAAC MILLER. U. S. 84,317, June 9, 1931.

Bird bath. EARLE S. SMITH. U. S. 1,806,123, May 19, 1931. In a bird bath, in combination, a vertically disposed pedestal having an opening in its upper end, a removable water pan having a projection depending from its bottom, the opening in the column being adapted to receive the projection on the pan, and a receptacle formed by an integral partition in the pan adjacent to its periphery adapted to receive bird food.

Surface treatment of synthetic precious stones. HERMANN ESPIG AND WOLFGANG TEUBNER. U. S. 1,806,588, May 26, 1931. The process which comprises treating the surface of synthetic precious stones, belonging to the class of corunds and spinels and being mainly composed of alumina, with fused anhydrous sodium tetraborate.

Surface treatment of articles made of synthetic corundum. HERMANN ESPIG AND WOLFGANG TEUBNER. U. S. 1,806,589, May 26, 1931. A process which comprises treating the surface of an article consisting of synthetic corundum with a fused substance containing a substantial amount of boracic acid.

Optical system for colorimeters, etc. JOHN W. FORREST. U. S. 1,806,621, May 26, 1931. In a colorimeter, an optical system comprising an ocular, two similar prisms, and a biprism disposed between the ocular and the similar prisms, each of the similar prisms having a surface disposed to receive light rays normally thereto, two surfaces for successively reflecting the rays, and a surface for refracting the rays.

Decorating glass. ALVA B. CARTER. U. S. 1,810,127, June 16, 1931. The method of ornamenting glass surfaces with pigments suspended in a slow-flowing medium which adheres to glass, the method consisting in applying the pigments in a plurality of colors

and shades to a suitable support in designs such that the suspended pigments in their medium will slowly flow toward each other to blend at the edges, in then applying a piece of glass to the pigment-treated support, in removing the glass with some of the pigment adhering thereto in the blended design, and in finally flooding the pigment-treated surface of the glass with a white pigment in a similar medium to provide for a blending of the reflected light rays in addition to the blending of the pigments.

Cement, Lime, and Plaster

Rapid determination of magnesia in Portland cement. CH. ROGOSINSKI. *Tonind.-Ztg.*, **55** [24], 355–56 (1931).—One g. cement and 5 cc. water are mixed in a porcelain dish, decomposed with 15 cc. hydrochloric acid (1 part HCl with specific gravity 1.19 + $2H_2O$), the mixture is kept cold and stirred constantly, then boiled almost dry for 2 hr. over a water bath. The residue is moistened with 5 cc. HCl 1:1, covered with a watch glass, and left for 10 min. in the cold. Twenty to 25 cc. hot water are added; it is then stirred, covered with the watch glass, and left over the water bath 5 minutes. The solution is diluted to 60 or 70 cc. with hot water, the remaining liquid decanted through a filter, and the residue washed with water 3 times. The filtrate is placed in a 400-cc. beaker, diluted to about 150 cc. with cold water, stirred constantly, and mixed with drops $^1/_5$ normal NaOH from a burette until the liquid begins to be turbid. From this moment it is stirred after every 4 or 5 drops NaOH are added and watched carefully to note whether the precipitate begins to ball and settle rapidly. The liquid remains turbid immediately after the precipitation. Only 1 drop NaOH is added at a time and it is stirred until the precipitate settles completely and the solution is clear. This is easier to observe if a filter is placed close behind the beaker. The filter remains yellow until the liquid is clear when it shows white. The liquid is filtered off and the filtrate caught in a 300-cc. flask; the precipitate is placed on the filter and washed 3 times with boiling water. When the filtrate is well cooled, 30 cc. $^1/_5$ normal NaOH is added from a burette, then filled up to the mark with cold water, thoroughly mixed, and left to stand in the sealed flask for a half hour. The precipitated $Mg(OH)_2$ settles and the solution becomes clear. The latter is carefully removed, filtered through a dry filter, and the filtrate collected in a 300-cc. flask in which 30 cc. $^1/_5$ normal HCl has previously been placed. This is mixed in the sealed flask, placed in a beaker, and rinsed with water; 10 drops of 1% phenolphthalein solution are added and the solution titrated with $^1/_5$ normal NaOH till the rose color remains. The number of cc. $^1/_5$ normal NaOH which is equivalent to the precipitated magnesia is calculated according to the following formula: $30 - (30 - a)\frac{30}{27}$. If flasks of different volume are used, the formula reads $A - (A - a)\frac{B}{C - A}$ where a equals the cc. $^1/_5$ normal NaOH necessary for titrating back; A, the cubic centimeter of the $^1/_5$ normal solution used; B, the volume of the flask in which the first filtrate was placed; C, the volume of the flask in which the second filtrate was placed. By multiplying the calculated number by 0.4, the magnesia content in per cent is obtained. Cements with a larger magnesia content were prepared by adding pure magnesia to the test cement. A table shows the results obtained by this method in comparison with those obtained by the phosphate method. From the table it is seen that the method gives results about 2% too high for cements with a low magnesia content. This is explained by the fact that the last traces of the sesquioxides are precipitated with an excess of NaOH. In cements with a large magnesia content, appreciable quantities of magnesia are absorbed through the R_2O_3 precipitate and the errors tend to equalize each other. The method gives exact results in this case. M.V.K.

Effect of sulphur on Portland cement mortar. MILES N. CLAIR. *Rock Prod.*, **34** [12], 68–69 (1931).—C. presents data, graphs, and tables on the effect of sulphur on the strengths of neat Portland cement and 1:3 Portland cement mortar. Free sulphur in materials used for making concrete is objectionable, particularly where it exceeds 1% by weight of the cement. W.W.M.

Criticism of research of tricalcium silicate. E. JAENECKE. *Zement*, **20** [2], 26 (1931); *Rock Prod.*, **34** [11], 95 (1931).—J. has studied an article by Brownmiller and Bogue entitled "The X-ray Method Applied to a Study of the Constitution of Portland Cement" (see *Ceram. Abs.*, **10** [2], 97 (1931)), and concludes from criticisms of this and his own work (*Ibid.*, **9** [4], 255 (1930)) that contradictions concerning the constitution of the Portland cements, which for the present appear unsolvable, must be cleared through new investigations. W.W.M.

Manganese and cement. Q. SESTINI. *Giorn. chim. ind. applicata*, **13** [2], 76 (1931).—Since manufacturers of slag cements have been using Thomas slags and slags from steel refining which contain as much as 16% MnO, it is important to understand the hydraulic properties and the action of Mn in the firing of clinker. According to Grün (see *Ceram Abs.*, **4** [8], 213 (1925)) the hydraulic properties diminish with increasing Mn content; also, 5% Mn in slag reduces the resistance of a cement to about half. The work of Guttmann and Gille (*Zement*, No. 16, 17, 18 (1929)) showed that slag containing Mn added directly to cement is injurious; slags containing up to 6% Mn_2O_3 can be used for Portland cement clinker. In this case the Mn unites with the Fe_2O_3 and Al_2O_3 to form the "celite" of cement, which differs slightly from the ordinary type and therefore is called manganocelite, although it has the same efficiency as the other. The formula of manganocelite is $4Ca{\cdot}Al_2O_3(Fe,Mn,Ti)_2O_3$ in mixtures with aluminates and ferrites of calcium. S. concludes that it is possible to use slags containing up to 6% Mn_2O_3 to prepare Portland cement clinker, but if the slags are to be added ground to natural or artificial cement clinker, they should have a minimum Mn content. M.V.K.

Cements and plasters of anhydrite. A. E. FLYM. *Rev. mat. constr. trav. pub.*, No. 259, pp. 140–45 (1931).—Tabulated results are given of the following tests on cements and plasters of anhydrite: (1) influence of fineness of grinding, (2) influence of impurities, (3) comparison of natural and artificial anhydrite, (4) tests with chemically pure sulphate, and (5) tests with calcined anhydrite. The conclusion is drawn from these results that cements and plasters can be made at a lower price from anhydrite than from any other material. M.Y.H.

Gypsum and gypsum products manufacture. X. Chemical analysis of gypsum. S. G. MCANALLY. *Rock Prod.*, **34** [12], 66–67 (1931).—McA. deals with the chemical end of the work of a gypsum products plant laboratory, particularly with the determination of anhydrite. Determination of retarder content is described. Sample calculations and tables are presented. For Part IX see *Ceram. Abs.*, **10** [7], 482 (1931). W.W.M.

Improving cement. WALTER MARSCHNER. *Tonind.-Ztg.*, **55** [34], 494–96 (1931).—Four different methods for improving the quality of cement are described. (1) Dust from blast furnace gas is cleaned, dried at 300°, and added to cement. If the slip is dried by blast-furnace gas at over 300°, it loses its hydraulic properties which increases the strength of cement. Portland cement with an admixture of 5% dried gas slip has a resistance to pressure of 567 and 772 kg./sq. cm. after storing for 7 and 28 days in water, and 869 kg./sq. cm. after 28 days' air storing. With 10% dried gas slip it has a resistance to pressure of 598, 848, and 933 kg./sq. cm. under the same conditions. (2) The addition of 2 to 3% gypsum and barium chloride shortens the setting time in the second method. According to the equation, $CaSO_4 + BaCl_2 = BaSO_4 + CaCl_2$, the gypsum is converted into barium sulphate, the retarding action of gypsum on the setting is elimi-

nated, and the simultaneous formation of calcium chloride promotes the setting which is rapid. By adding more calcium chloride to the diluting water, the strength of the cement is increased. (3) This method uses raw and overfired gypsum as admixtures to cement. The gypsum and cement are ground in a special manner. (4) This method is used by the International Cement Corp. in New York. M.V.K.

Synthesis of cement in the parallelogram of four components and the degree of lime saturation. HANS KÜHL. *Tonind.-Ztg.*, **55** [22], 320–22 (1931).—K. explains the difference between the degree of saturation of lime as he means it and the quotients of Hess and Spindel (see *Ceram. Abs.*, **7** [7], 491 (1928)). He gives his definition of the degree of saturation of lime as the per cent of the actual lime content in a substance with the highest possible lime content, as seen by the formula, $S = \frac{100CaO}{2.8SiO_2 + 1.65Al_2O_3 + 0.7Fe_2O_3}$. See also *Ceram. Abs.*, **7** [7], 428 (1928); **10** [6], 410 (1931). M.V.K.

Cement synthesis in the 4-substance parallelogram. M. SPINDEL. *Tonind.-Ztg.*, **55** [21], 305–307 (1931).—S. discusses the determination of the composition of Portland cement clinker on the 4-substance parallelogram and the degree of lime saturation according to Kühl. See preceding abstract. M.V.K.

Spalling of cold water cakes. E. RISSEL. *Tonind.-Ztg.*, **55** [41], 600–603 (1931).—In most cases, spalling of cement cakes in cold water is believed to be caused by too high gypsum content of the cement. R. has found, however, that in some cases other reasons may be responsible for this phenomenon. The entire question should be studied further. W.M.C.

Cement in theory and practice. V. Chemistry of high-strength cements. HANS KÜHL. *Cement & Cement Mfg.*, **4** [2], 161 (1931).—The most important chemical consideration in the production of high-strength cements is the choice of lime and silica contents which will result in the greatest possible quantities of alite and celite. Perfect clinkering is also important. Rapid cooling improves hardening properties. For Part IV see *Ceram. Abs.*, **10** [7], 481 (1931). W.L.

Quicker tests of cement and concrete. H. KREÜGER. *First Communications New Internat. Assn. for Testing Materials, B*, 114–18 (1930).—Preliminary tests made to investigate whether it might be possible to decide quickly (in 1 or 2 days instead of 28 days) whether a cement is fit for delivery showed that there probably is a fairly good concordance between the normal crushing strength of cubes after 28 days' combined air and water curing and after a few hours' steam hardening. The method may be of some use also for quicker testing of concrete, but has not yet been satisfactorily developed. (*C.A.*)

First installation of wet grinding in closed circuit in America. LEWIS R. SIMS. *Concrete; Rev. mat. constr. trav. pub.*, No. 259, pp. 149–55 (1931).—Results obtained at the Dewey-Portland Cement Co., Davenport, Iowa, from wet grinding in closed circuit are presented. M.Y.H.

Rumanian trass. A. STEOPOE. *Tonind.-Ztg.*, **55** [30], 436–38 (1931).—S. discusses the capability of reaction and technical properties of Rumanian trass, and describes tests with trass lime mortar and trass cement mortar. The results are tabulated. M.V.K.

Tentative specification for high-alumina cements. ANON. *Structural Eng.*, **8** [10], 369–73 (1930). (*C.A.*)

German standard specification for alumina cements. H. VIERHELLER. *Tonind.-Ztg.*, **55** [22], 325–26 (1931).—Changes and supplementary items for the present standard specifications for alumina cements in Germany are presented. See also *Ceram. Abs.*, **10** [2], 100 (1931). M.V.K.

Japanese researches on cement. C. R. PLATZMANN. *Tonind.-Ztg.*, **55** [29],

424–25 (1931).—A compilation is presented of the Japanese researches on cement and its aggregates. M.V.K.

PATENTS

Scaffold for lining rotary kilns. Process for producing rapid-hardening slag cement. SUPECIMAR S.A. Ger. 498,202, Aug. 5, 1926; *Tonind.-Ztg.*, **54** [48], 796 (1930); *Rock Prod.*, **33** [19], 87 (1930).—In this process, slag, clinker, etc., and lime combined with sulphuric acid (gypsum, anhydrite, carstenite, etc.) are dried, separately ground, cooled to a normal temperature, and mixed. Lime is more finely ground than slag. Slag, clinker, and anhydrite are mixed in proportion 8 : 5 : 15. Carstenite with a content of water of crystallization or gypsum with a total water content of 5% is used. Gypsum is dried and ground till it reaches the necessary dryness and fineness. The cement hardens rapidly and contains a high strength from the beginning of setting. M.V.K.

Dental cements. HANS HEYNEMANN. Ger. 520,138, Sept. 30, 1927. In the manufacture of these, by preparing oxides, phosphates, or silicates of one or more metals of the second or third periodic group by a sintering or fusion process and then mixing the product with H_3PO_4, a compound of Li is added to the material to be fused or sintered. A lower temperature can then be applied without increasing the solubility of the final product. (*C.A.*)

Enamels

Production of white, heat-resisting, enamel ground coats. ANON. *Keram. Rund.*, **39**, 25 (1931).—To obtain a good ground coat with good covering power, resistant to as high a temperature as 950°C, and using only a small amount of an opacifier such as tin oxide, the SnO_2 is added with the mill addition together with a fairly large amount of clay and an alkaline-earth carbonate to raise the viscosity of the melting enamel. An enamel suitable for a temperature of 950°C is composed of 23% borax, 47.2% feldspar, 15.4% cryolite, 13.5% quartz, and 0.9% Na_2CO_3. This is fritted and the following ingredients are added in the mill: 60% water, 8% clay, 6% SnO_2, 20% kaolin, 20% $CaCO_3$, 1.0% MgO, and 1% Na_2CO_3. H.I.

Enameling cast iron. ANON. *Emaillewaren-Ind.*, **8** [13], 11–12; [18], 20–21 (1931).—Enameling cast iron is more complicated than enameling sheet metal, and its success depends on the chemical and physical properties of the cast iron. The cast iron is enameled in two ways, *i.e.*, the powder method and wet method. The ground coat is composed of 70 parts quartz and 30 parts borax. The fritting must be carefully done so as not to dissolve the layer of iron oxide which assures the adherence of the enamel to the cast. Fusing requires about 1½ hr. at a temperature of 800 to 900°. After fusing, the fritted mass must have a light, lustrous surface. It is sprinkled with cold water, crushed, and ground. From 15 to 35% quartz and clay and 1 to 3% sodium carbonate are added to the mill. The fritted mass is applied to the cast iron (1) by plunging the cast iron into the mass, or (2) by using a vaporizer. Both methods are described. M.V.K.

Some notes on enameling castings. A. M. CLEVERLEY. *Foundry Trade Jour.*, **44**, 246 (1931).—Castings should be sent to an enameler as soon as possible after being made, since they absorb moisture. No faking of defective castings should be permitted. The section of the casting should be uniform. Porous metal is formed at heavy portions and the enamel does not fuse correctly on these colder surfaces. Allowance should be made for growth of castings after the furnace. Wet-process enamels tend to warp less than dusted enamels. H.H.S.

Correct finishing. FRED MCC. BURT. *Ceram. Ind.*, **16** [6], 535–39 (1931).—The important properties of a cover coat are the gloss, the close-textured finish, even opacity

of its colors, clean-cut shades, beauty of design, and resistance to impact, scratches, and acid and alkalis. B. discusses the proper fusion point of enamel coats and the effect of various ingredients on the properties of enamel. The determination of proper fineness of grind, dipping troubles, and necessary spraying equipment are discussed. Some of the features of dry-process enameling procedure are described. A list of cover-coat defects is given with reasons for them. W.W.M.

Control of ground coat draining time. H. G. WOLFRAM. *Amer. Enameler*, **4** [3], 14 (1931).—The time of draining of the ground coat has become of primary importance. An investigation is described to prove that even as small an increase as ten seconds in the time required to drain a unit may hold up the schedule at some time during the day. J.D.R.

Calculating the enamel batch. ANON. *Emaillewaren-Ind.*, **8** [19], 146–47 (1931).—The importance of having the correct values for the properties of enamels is shown and methods of calculating these values are given. M.V.K.

Measurements of tensions between enamel and the ground material. ANON. *Emaillewaren-Ind.*, **8** [12], 90 (1931).—Different methods for determining tensions between the enamel and the ground are discussed and it is concluded that the method of calculating the expansion of enamel and comparing it to the expansion of the plate is more rapid and simple. M.V.K.

Measurement of strains between enamel and the underlying material. RUD. MEYN. *Keram. Rund.*, **39**, 61–62 (1931).—Thin specimens of sheet iron or gray cast iron about 300 mm. long and 10 mm. wide are enameled on one side for the center third of their length and the warping of the sheet due to unequal contraction of metal and enamel is measured with a telescope. The specimen is fastened in a holder by one end and the telescope sighted on the free end. Either one of two muffles, both electrically heated, may be slid over the specimen. One muffle is used for heating the specimen and the other for slow cooling if that is desired. Thus commercial conditions of enameling may be simulated and the warping of the sheet during all the operations may be observed. Relative amounts of warping for different enamels on the same metal or for the same enamels on different types of metals may be measured. H.I.

Bubbles and needle tappings in enamels. WALTER KERSTAN. *Emaillewaren-Ind.*, **8** [19], 147–48; [20], 153–55 (1931).—After reviewing current literature on this subject, K. concludes that (1) changes in the enameling operation greatly affect the tendency of the given cast to produce bubbles in the enamel. (2) There is a decided difference in the tendency of different cast irons to produce bubbles although enameled under similar conditions. (3) Different charges of the same crude iron, even when fused in the same electric kiln, vary in their tendency to form bubbles. (4) The treatment of the enameled objects at 500°C before firing usually reduces the tendency to form bubbles. (5) Even though the state of the cast irons and the method of firing have considerable influence on the formation of bubbles, the worst source of the trouble from the iron used lies in a very thin surface layer. The chemical or mechanical removal of this layer works a great improvement. See also *Ceram. Abs.*, **10** [5], 329 (1931). M.V.K.

Needle tappings and rust spots on cast enamels. ANON. *Emaillewaren-Ind.*, **8** [15], 113–14 (1931).—Needle tappings in enamels are caused during firing by the action of the moisture absorbed by pores of the cast iron when the wet ground enamel is applied. The moisture evaporates suddenly during firing and the steam forces out the enamel. The ground enamel does not close the pores and when a white coat is applied, this phenomenon is repeated producing needle tappings in the enamel. Rust spots appear in the following way: Oxygen from the air decomposes iron sulphide, present on the surface of the cast, into sulphate of iron. The enamel mass is always

alkaline and it enters into reaction and forms the ferro carbonate ($FeCO_3$) which with oxygen and water changes into the red-brown ferric hydroxide (the rust spot). The escaping gas is carbonic acid. During firing of the enamel layer, the water is liberated and ferric oxide remains as rust. The same process takes place in pores of cast iron. Salts combined with sulphuric acid do not disintegrate during enameling and remain in the pores. Means of avoiding needle tappings are (1) use of casts free from pores and fissures, (2) filling pores with a substance which evaporates easily (cast iron treated with petroleum gives good results), and (3) using ground enamels which run during firing. M.V.K.

Fish scales in plate enamels. VIELHABER. *Emaillewaren-Ind.*, **8** [12], 89 (1931).—Fish scales in black plate enamels are produced by nickel oxide. The black bodies consist of a mixture of dark coloring oxides, *i.e.*, manganese, copper, cobalt, black iron, and nickel oxides. Nickel oxide is the cheapest and is therefore used in greater quantities. The mixture is heated to redness, washed, and ground. During heating to redness nickel oxide gives up its oxygen to the other oxides so that during fusing it is already present as nickel metal or is reduced to it. M.V.K.

Firing enamelware. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [17], 129–30; [18], 137–38 (1931).—L. describes different methods of firing enamelware, *e.g.*, bath tubs, coffee pots, dishes, buckets, etc. M.V.K.

Action of a mixture of several opacifiers. VIELHABER. *Emaillewaren-Ind.*, **8** [12], 90–91 (1931).—The strength of every opacifier has a limit over which opacifying ceases to increase perceptibly, but if it is combined with another opacifier, the opacifying continues to increase. A German cast-iron enamel plant uses tin oxide, leuconin, and terrar for opacifying, adding the three substances to the mill. A series of opacifiers consists of mixtures of tin oxide and kaolin, leuconin and kaolin, or tin oxide, leuconin, and kaolin. The opacifying effect of such mixtures is greater than that obtained by using a corresponding quantity of a pure opacifier. M.V.K.

Opacifier, "terrar," for production of white enamel coatings. WILHELM LINKE. *Sprechsaal*, **64** [10], 193–94 (1931); for abstract see *Ceram. Abs.*, **10** [1], 20 (1931). M.V.K.

Cloud effects on enamels. ANON. *Emaillewaren-Ind.*, **8** [15], 114–15 (1931).—The ware is coated with a simple ground enamel, then with a thin gray coat on which the effect of clouds is obtained. The gray coat is made without clay and, to increase the effect of clouds, a greater quantity of opacifier is used (about 10%). The gray coat is afterwards glazed. A special installation for obtaining cloud effects is described. M.V.K.

Boron instead of borax. ANON. *Emaillewaren-Ind.*, **8** [11], 83 (1931).—The use of the mineral boron instead of borax for preparing enamels (because borax is never found in pure form and must be refined) is discussed. The composition of mineral boron is 14.23% water, 13.72% quartz, 1.90% iron oxide and alumina, 0.90% lime, 45.15% boric acid, 2.43% magnesia, 20.83% soda, 0.10% sulphuric acid, 0.74% carbonic acid, and traces of chlorine. By calculation, 100 parts of this mineral equal 123.65 parts of crystallized borax. Tests made with it gave perfect enamels. M.V.K.

Feldspar in enamels. ANON. *Emaillewaren-Ind.*, **8** [9], 7–9 (1931).—Feldspar is an important ingredient of enamels. There are three kinds of feldspar used for plate and cast enamels: (1) feldspar with potash, (2) feldspar with soda, and (3) mixed feldspar containing potash + soda. The ideal composition of the first is 64.72% SiO_2, 18.35% Al_2O_3, 16.93% K_2O; of the second, 68.84% SiO_2, 19.40% Al_2O_3, 11.97% Na_2O; mixed feldspar generally contains $K_2O + Na_2O$ from 14 to 20%. A good feldspar must not contain more than 64 to 68% SiO_2 as otherwise its fusing point would be too high. The feldspars mentioned have a fusion point at about 1200°, while a feldspar containing

75% SiO_2 fuses at 1450°. The increase in silicic acid content in a feldspar diminishes the Al_2O_3 and K_2O contents which are important ingredients. The first acts as an opacifier and the second lowers the fusing point. Feldspar containing potash gives a better quality of enamel than feldspar containing soda, as the dilation of K_2O equals 8.5 and that of Na_2O = 10. Although alumina is indispensable in an enamel, its influence is injurious for the elasticity of an enamel. M.V.K.

Fluorspar. VIELHABER. *Emaillewaren-Ind.*, **8** [13], 97–98 (1931).—Fluorspar always contains impurities such as lime combined with carbonic acid, quartz, and alumina. Fluorspar acts differently according to the impurities present. The melting point of fluorspar is near 900°. A small part of it disintegrates and forms oxyfluoride which lowers the melting point. The fusion is a milky opaque mass. This turbidity appears also when the enamel is fused; thus fluorspar increases the opacity of enamels. Alkali carbonates present during the fusing of an enamel partially disintegrate the fluorspar and influence its behavior. The addition of fluorspar always depends on the quantity of alkali carbonates. Such enamels are stable to sudden temperature changes and to acids and they have a good luster and opacity when a suitable opacifier is used. Fluorspar also increases the inner strength of enamels and is often used for ground enamels. M.V.K.

Sodium silicate, a new enamel raw material. M. E. MANSON. *Jour. Amer. Ceram. Soc.*, **14** [7], 490–94 (1931).

Control of draining consistencies of enamels by addition of sodium silicate. DWIGHT G. BENNETT. *Jour. Amer. Ceram. Soc.*, **14** [7], 495–98 (1931).

X-ray inspection of castings. ANON. *Jour. Soc. Automotive Eng.*, **25**, 551 (1929).—The advantages of X-ray examination of castings, especially of castings of new or unusual design, are presented. (*J.I.M.*)

X-ray technique in the foundry. R. DRAHOKOUPIL. *Zentral-Europ. Giess.-Zeit.*, **3** [1], 13 (1930).—The rapid extension of the use of the X-ray in the examination of metals and alloys has brought it within measurable reach and almost to a necessity for the modern foundryman. The examination of casting failures and blowholes, crystal orientation, recrystallization phenomena, etc., has become almost stereotyped, and foundry work is being judged by these high standards in addition to those used heretofore. D. indicates some of the ways these methods are now being applied and briefly surveys the technique involved. (*J.I.M.*)

Use of electrical temperature-measuring instruments in foundries. ANON. *Zentral-Europ. Giess.-Zeit.*, **2** [12], 8–11 (1929).—Various optical and recording pyrometers are described. There is also a short discussion of immersion pyrometers for ascertaining casting temperatures and of the Siemens ardometer. (*J.I.M.*)

Power cost on an electric enameling furnace. M. E. MANSON. *Jour. Amer. Ceram. Soc.*, **14** [7], 499–501 (1931).

New full muffle-type enamel furnace. H. C. JURS. *Ceram. Ind.*, **16** [6], 562–64 (1931).—J. describes the construction of a new type muffle furnace for enamelware production. Sprung arches are not used in any part of the furnace, thus preventing troubles from expansion. The flue structure is free to move up or down with expansion or contraction of the tubes which carry the heat to the muffle. These tubes are vertical in the sides of the muffle and the flue rests on top of them. The muffle has been tested at a temperature of 2000°F and at that temperature the hand can be held on the outside walls of the furnace. At temperatures above 1000°F no variation can be seen inside the muffle with the naked eye. The furnace can be built with almost any dimensions. Only standard firebrick shapes are used except for the tubes and suspended arch. All walls, flues, tubes, floor, and supports are built in vertical planes and are self-supporting. The construction of the furnace allows an increase in combustion volume. Preliminary

tests have shown an efficiency of nearly double that of any other fuel-fired furnace. The heat-radiating area of the muffle is much greater than for other types of muffle furnaces. W.W.M.

Kilns in enamel industry. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [10], 73–74 (1931).—L. describes different types of enamel kilns with direct firing, gas, and part gas firing. M.V.K.

Spraying equipment. I. S. M. STOLER. *Amer. Enameler*, **4** [2], 6 (1931).—S. discusses spray guns in detail from the standpoint of compressed air, the amount of air required, its care, and the equipment pertaining to its use. **II.** *Ibid.*, **4** [3], 6–8 (1931).—Feeding enamel to spray guns is discussed fully. The syphon-cup, gravity, and pressure methods are explained in detail, in addition to instruction as to use and care of equipment. J.D.R.

Spraying reflectors inside and out. ANON. *Ceram. Ind.*, **16** [6], 539 (1931).—The procedure of spraying first and second coats on reflectors at a modern plant is described. W.W.M.

Uses of waste pickling liquor in enamel factories. ANON. *Emaillewaren-Ind.*, **8** [11], 83–84 (1931).—It is suggested that instead of throwing away waste pickling liquor which must be treated to neutralize the remaining salts, it may be used for preparing marketable products such as vitriolic iron from a sulphuric acid pickle and iron chloride or red iron oxide from hydrochloric acid pickle. Methods of producing these are given. M.V.K.

Pickling and allied cleaning operations. MATTHEW W. BUTLER. *Metal Cleaning & Finishing*, **3** [5], 423–26 (1931).—A complete outline of the cleaning and pickling operations followed in connection with the vitreous enameling of metal parts is presented. Illustrated. E.J.V.

Equipment for the cleaning of metal. V. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [5], 377–82 (1931).—The subject of cleaning tank-heating equipment is begun with a detailed description of steam heating and its application. For Part IV see *Ceram. Abs.*, **10** [7], 484 (1931). E.J.V.

Continuous equipment controls quality. ANON. *Factory & Ind. Management*, **81** [6], 963–65 (1931).—A description of the continuous enameling processes employed by the Leonard Refrigerator Co. is presented. E.C.C.

Metalkeramic. FRANZ SKAUPY. *Verlag Chemie; Refrac. Jour.*, **7** [5], 274 (1931).—Much attention has recently been aroused in a new method of working metal as though it were a plastic material like clay, the ordinary clayworking methods being used after the necessary modification. The metal is powdered, screened, and then pressed to the desired shape, after which it is heated to the sintering point, whereby its shape is "fixed" and a hard dense body is produced. Very little information has as yet been published on the matter, though a useful book has recently been issued in Berlin. See also *Ceram. Abs.*, **9** [11], 995 (1930). E.P.R.

Color problems and sales stimulation. HAZEL H. ADLER. *Amer. Gas Jour.*, pp. 58–59 (March, 1931).—It is difficult to buy a set of matched kitchen equipment because manufacturers of stoves, sinks, refrigerators, and kitchen cabinets have failed in turning out colors that harmonize. To remedy the present condition, utility companies must get manufacturers to produce, on a sound merchandising basis, equipment in colors that will match with other related major pieces in the kitchen. (*D.I.*)

College and the enameling industry. A. F. GREAVES-WALKER. *Amer. Enameler*, **4** [3], 3–5 (1931).—Due to the tremendous development of the enameling industry, ceramic departments in leading universities and colleges have strengthened and improved their courses. Opportunities for ceramic graduates are increasing daily and increasing numbers of students are enrolling. J.D.R.

Frigidaire and the three year guarantee. ANON. *Amer. Enameler*, **4** [2], 14 (1931).—The three year guarantee on Frigidaires has been instituted, among other reasons, because of the permanence and durability of the porcelain enamel finish on all household models. Frigidaire is using a new acid-resisting enamel, and the acid and fruit-juice tests to which it was first subjected are explained fully. J.D.R.

BOOKS

Stamping and Enamel Calender, 1931. MAX THIELE AND WALTER KERSTAN. Illustrierte Ztg. für Blechind. und Installation, Leipzig, 1931. Rm. 3.30. Reviewed in *Sprechsaal*, **64** [8], 158 (1931).—This book contains the latest achievements of the enamel industry. Chapters are devoted to the chemico-physical properties of the enamels, raw materials, their composition and preparation, heat technical supervising of fusing and muffle kilns, refractory materials, manufacture of enameled objects, and standardization of cooking utensils. M.V.K.

Bibliography of the metallurgical work of the U. S. Bureau of Mines in 1930. R. S. DEAN. Bur. Mines, *Information Circ.*, No. 6449, 7 pp. (1931). R.A.H.

PATENTS

Enamels. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Fr. 695,609, May 14, 1930. Enamels which are resistant to acids are made by melting together Li_2SiO_3 or a eutectic mixture of Li_2O and SiO_2 with a flux such as minium. (*C.A.*)

Rotary furnace for enameling and glazing. MITTELDEUTSCHE STAHLWERKE A.-G. Ger. 496,973, Feb. 28, 1928. Structural details are given. (*C.A.*)

Enameled designs on metal surfaces. HUGO DEBACH. Ger. 516,607, Aug. 27, 1927. The metal surface is prepared chemically or electrochemically with layers which give the enamel the coloring of metal compounds. These layers are then covered with a transparent enamel or glaze. The whole is then heated until the latter layer fuses. Several examples are given. In one a Cu surface is galvanically silvered and then galvanically coppered, thickly for red parts and thinly for green parts. Electrolysis in a bath of 2% $NaNO_3$ and 1% Na_2CO_3 leaves the plate with a deposit of Cu which is shaded off into the desired light, shade, and color effects by a rotating or scraping tool. The coloring effect may be enhanced by underglaze pigments. The plate is then covered with glaze powder and heated in a muffle furnace. (*C.A.*)

Muffle furnace for enameling sheet-iron ware. MANFRED WEISS STAHL- UND METALLWERKE A.-G. Swiss 141,563, May 21, 1929. (*C.A.*)

Glass

Design and construction of polariscopes for use in glass factories. C. D. SPENCER AND SHANNON JONES. *Jour. Amer. Ceram. Soc.*, **14** [7], 512–17 (1931).

Index of refraction of some soda-lime-silica glasses as a function of the composition. C. A. FAICK AND A. N. FINN. *Jour. Amer. Ceram. Soc.*, **14** [7], 518–28 (1931).

Devitrification of "Pyrex" glasses. GEORGE W. MOREY. *Jour. Amer. Ceram. Soc.*, **14** [7], 529–31 (1931).

Problems of glass state. BERGER. *Sprechsaal*, **64** [18], 334–35 (1931).—B. discusses glass as a fourth state of matter with gases, liquids, and solids. From this point it may be considered an undercooled liquid. When hard, brittle glass is formed by the cooling of a liquid which, unlike crystal, is thermodynamically unstable below the fusing point, the brittle glass state is sharply marked off from the undercooled liquid by

the transformation point at which the coefficients of temperature, volume, heat content, refraction, viscosity, electric conductivity, dielectric constants, etc., suddenly change. According to the theory of continuity, if the liquid always consists of pure molecules, the liquid state should extend to absolute zero when crystallization ceases. Here the kinetic energy of the molecule would disappear (heat motion) and the volume would attain its minimum value. At absolute zero, therefore, the homogeneous particles of a liquid would come together and form a rigid body. The theory of continuity is not followed by any substances, especially liquids, as their molecular state changes during cooling. It is known that many substances composed of different kinds of molecules form molecular groups or aggregates. Technical glasses as mixtures have no distinct melting point but have a temperature at which the viscous state, the so-called aggregation point, begins. Meyer-Bjerrum and Salzwedel found empirically that aggregating (associating) liquids act during cooling as though they had reached a limit state at a certain temperature, T_o, above absolute zero. This temperature limit cannot be th melting point, but the transition into the crystalline state. Formulas for viscosity advanced for associating and glassforming liquids show the same thing. B. refers to the works of Fulcher and Tammann. The formulas for the temperature limit allow the viscosity to be infinitely large, while empirically they give an equal value $\eta = 10^{13}$ for the height for all substances. It must therefore be assumed that the concentration of aggregates in the liquid grows constantly with decreasing temperature owing to the progressive (dynamic) aggregation, *e.g.*, the double molecule dissolves into the simple so that a limit volume is reached at T_o at which the aggregates come in close contact. The most dense packing is often possible at a temperature above absolute zero only through the fact that energy is liberated by the formation of double molecules or polymolecules. If these could be forced into the system at the constant temperature T_o, then the parts of the double molecules would attain a certain distance and mobility and the limiting volume would be reached, not at T_o, but at absolute zero. Something corresponding must be accepted for the transformation point at which the undercooled liquid changes into the brittle glass state with the change of property-temperature coefficients. The glass particles at this point are also in direct contact and form a rigid body whose changes in properties on cooling are no longer molecular kinetic but can be described as atom kinetic. Brittle glass therefore represents a fourth state of matter which is different from the crystalline state though similar to it in many respects. It can be conceived as a modification of the solid state. In any case, it does not represent an undercooled liquid. That a dynamic aggregation takes place in the undercooled liquid and in brittle glass follows from the dependence of the properties of glass on heat treatment. Chemical changes (the dynamic aggregation) which with the physical magnitudes, *i.e.*, pressure, volume, and temperature, determine the state of a substance, begin perceptibly near the transformation point so that in brittle glass not completely chemically adjusted, arrested equilibriums are present under the transformation point with different property values according to the nature of the conditions interfering. The glass state can only be described thermodynamically for establishing chemical equilibrium. This is especially important for the question concerning the stability of the glass state. The measurement of energy content of glasses shows that for substances with a heat of fusion lower than 12 cal./g. the difference in energy between glass and crystal is negative. By taking into consideration the conditions which prevent the establishing of equilibrium, this will probably prove to be correct for substances with greater heat of fusion under the transformation point. In geologically old times, therefore, the glass state was more stable than the crystalline state in many ases; and at low temperatures, the most stable of all matter. The classification of the lass state is an important problem and must be settled by investigators and theorists in

order to develop the applied knowledge and laws on which to base the old technique of glass, if progress is to be made. M.V.K.

Viscosity of glass between the strain point and melting temperature. HOWARD R. LILLIE. *Jour. Amer. Ceram. Soc.*, **14** [7], 502–11 (1931).

Knowledge of the viscosity and expansion of glasses in the softening sphere. A. P. SACK. U.S.S.R., *Sci. Tech. Dept.*, No. 360; *Sprechsaal*, **64** [13], 248 (1931).—The dependence of the viscosity of glasses on the temperature was determined on the basis of the increase in length of glass rods when drawn. Two cracks were found in the curves of all glasses which corresponded to the transition from the thickly liquid into the brittle state and the beginning of deformation. Between these points, the curve course was linear. Similar disagreements were determined on dilatometer curves (dilatometer Chevenard). The curve cracks in hardened glasses lie at considerably lower temperatures, the lowest probably being identical to the lower temperature limit for cooling the type of glass concerned. M.V.K.

Crystal modes of the technical calcium-sodium silicate devitrification and their interpretation. HANS JEBSEN-MARWEDEL. *Sprechsaal*, **62**, 715–17, 735–39, 753–56, 773–76, 791–93 (1929); *Chem. Zentr.*, **I**, 878–79 (1930).—The forces active in the crystallization process surpass the "crystallizing ability" by the amount due to the inhibition on account of the internal friction. This more comprehensive term is called "crystallizing tendency." Many photographs of cristobalite and wollastonite crystals are given. The crystal modes are influenced by external factors; therefore they vary extensively. It is shown by means of crystals of an organic glass, that the directed crystallization forces of the skeletons can be altered by external factors. In this case the arrangement of the crystal pattern assumes a medium position. The modes of devitrification make it possible to draw important conclusions with regard to errors in the manufacture, which otherwise can be detected only by difficult and time-consuming investigations. It was found that the cristobalite crystals in the glass are subject to an unexplained torsion force which is perhaps to be attributed to an inhomogeneous melt. The hexagonal star-shaped crystals hitherto described in the literature as tridymite are cristobalite crystals. The surroundings of the crystals are so strongly altered by the formation of crystals that this secondary glass separates another phase. The wollastonite-cristobalite paragenesis thus found was followed and interpreted through all steps. Thus by crystallization the glass is fractionated into residual glasses, each of which assumes a new position in the equilibrium diagram. See also *Ceram. Abs.*, **8** [9], 647 (1929). (*C.A.*)

Calculation of the coefficient of thermal conductivity of glass. LEOPOLDO BUATIER DE MONGEOT. *Ind. Silicati*, **9** [2], 12 (1931).—A simplified method for calculating the coefficient of thermal conductivity of glasses is given with a description of the apparatus used. M.V.K.

Note on refractive index, atomic size, and packing in glasses. J. T. RANDALL AND N. GEE. *Jour. Soc. Glass Tech.*, **15** [57], 41–53 (1931).—An attempt was made to calculate refractive indices of glasses from fundamental considerations. Using values of density given by Peddle, and by English and Turner, the validity of the Lorenz-Lorentz relation $\Sigma R = \frac{M}{\rho} \cdot \frac{n^2 - 1}{n^2 + 2}$ was tested. The calculations assume that the elements in glasses are in the ionic form and are based on Wasastjerna's values of refractivity. Observed and calculated values agree fairly well. Using the values of "atomic" size deduced from the recent work on crystalline silicates by W. L. Bragg (see *Ceram Abs.*, **10** [1], 73 (1931)), it was found that actual molecular volume in $Å^3$ is nearly proportional to the sum of the volumes of the individual atoms in the "molecule." The mean value of the packing factor for the 28 glasses examined is 2.065 as compared with the value

1.34 for cubic close packing. Assuming $V_M = k\Sigma V_A$ we can write $\Sigma R = 1.244\Sigma V_A \cdot (n^2 - 1)/n^2 + 2$, a formula which depends only in ionic constants for individual atoms. Values of n were again calculated, but the discrepancies were greater than before, and an attempt was made to show a connection between fundamental and empirical formulas. G.R.S.

Syntheses of frit stones. F. Eckert and F. H. Zschacke. *Sprechsaal*, **64** [12], 227–29, 243–45 (1931).—The authors investigated the tendency of different raw materials to form frit stones during fusing. A technical glass of about 68% SiO_2, 20% alkali, 7% CaO, 4.5% Al_2O_3, and a small quantity of boric acid was used. It was clarified with 1% Na_2O and a small quantity of sulphate. The raw materials investigated were (1) feldspar sand (pegmatite) dry and moistened, (2) phonolite in small fragments, (3) kaolin in lumps dry and moistened, (4) aluminium hydroxide (hydrate of alumina) dry and moistened, (5) sand dry and moistened, (6) soda in lumps dry and moistened, (7) sodium sulphate dry and moistened, (8) potash (hydrate) in small lumps dry and moistened, (9) borax dry, (10) calcite dry and moistened, and (11) fired lime in lumps powdered and moistened. The analytical composition of these raw materials is tabulated, and the tests described. It was found that (1) the melting point and temperature of disintegration are equally important in the formation of stones. The greater the reacting power of the fusing substance, or of the substance originating from disintegration, the easier it enters the glass and the less likely it is to form stones, even when originally introduced in lumps. (2) The most important factor in the formation of stones is the difference in viscosity of the substance and its surroundings in connection with the velocity of diffusion or equivalent influences. These can offset the advantages of low fusing or disintegration points so much that stones can be formed. (3) Raw materials, which when melted are capable of forming glass, can form lumps and stones because of their high viscosity. (4) A finished clarified glass decomposes only slightly and very slowly. On the other hand, it is capable of absorbing larger lumps and stones. (5) Dry lumps form stones more readily than moistened. (6) The raw materials investigated are divided into four groups according to their tendency to form frit stones: (*a*) borax forms no stones even when coarse and inhomogeneous; (*b*) soda, potash, lime, sulphate, and sand show a limited tendency to form stones, especially at the beginning of fusing, owing to coarse lumps; (*c*) hydrate of alumina, pyrolignite of lime in hard lumps, sand lumps, kaolin, and fired lumps present in hydrate of alumina form stones; (*d*) alumina lumps, feldspar lumps, and phonolite fragments in short fusing periods tend to form glass stones. M.V.K.

Use of boric oxide in the glass industry. F. H. Zschacke. *Chem. Zentr.*, **I**, 879 (1930); for abstract see *Ceram. Abs.*, **9** [5], 338 (1930). (*C.A.*)

Currents and temperatures in glass tanks. G. Gehlhoff, W. Schneekloth, and M. Thomas. *Jour. Soc. Glass Tech.*, **15** [57], 12–29 (1931); for abstract see *Ceram. Abs.*, **10** [7], 491 (1931). G.R.S.

Stability of hardened glass at different distances from the surface. S. J. Joffe. U.S.S.R., *Sci. Tech. Dept.*, No. 360; *Sprechsaal*, **64** [13], 248 (1931).—Dissolving tests on hardened plates of fused borax show that the surface layer of the plate is less soluble in water than those lying deeper. This behavior agrees with the theory of distribution of tensions in glasses according to which the surface layer is made more dense while the deeper layers are loosened. The water solubility increases directly under the surface layer, but remains constant with a further penetration into the body. The loosened layers predominate in glasses. Weaker hardened glasses show a greater solubility at the same depth. Corresponding to the increase in the solubility of water in hardened borax glass, the density and the refractive index also change inward from the surface. M.V.K.

Temperature distribution in wired glass. ANON. Dept. Sci. Ind. Research, Bldg. Research Board, *Rept.*, p. 88 (1929).—The wire in the glass specimen (60 cm. x 15 cm.) forms part of a circuit so arranged that the potential difference across the ends of the wire can be measured and the wire thus acts as its own resistance thermometer. The specimen is exposed normally to the sun's rays in a shallow cork-lined box. A series of 8 waxes ranging from 40 to 60° melting point enables the temperature of the glass surface to be roughly determined by observing when the wax samples "slide" easily on the latter. Observations fail to show any measurable difference in temperature between the wire and the glass. (*J.S.G.T.*)

Reflection and transmission of radiation temperatures beneath glass. ANON. Dept. Sci. Ind. Research, Bldg. Research Board, *Rept.*, p. 89 (1929).—Specimens 3 ft. square of $^1/_4$-in. plate glass form the lids of two large boxes filled to within 4 in. of the glass with slag wool, and blackened copper plates laid on the latter are heated by radiation. Thermojunctions attached to the plates enable their temperature rise to be followed. After comparison of the boxes, one sheet of glass is whitewashed and a pronounced reduction in transmitted radiation is observed. The table below indicates the nature of the differences.

Condition of Glass	Temperature
Clear	110°
1 coat whitewash	55
2 coats whitewash	25
1 coat green distemper	70
2 coats green distemper	55

(*J.S.G.T.*)

Variations caused in heating curves of glass by heat treatment. A. Q. TOOL AND C. G. EICHLIN. Bur. Stand., *Jour. Research*, **6** [4], 523–52 (1931); Bur. Stand., *Tech. News Bull.*, No. 167, p. 26 (1931); for abstract see *Ceram. Abs.*, **10** [5], 332 (1931). R.A.H.

Scattering of light by turbid media. J. W. RYDE. *Proc. Roy. Soc.* [London], Part I, **131***A* [817], 451–64; Part II, 464–76 (1931).—In Part I the general theory is developed and in Part II numerical values of the necessary coefficients are computed. Opal-diffusing glasses were the dense turbid media studied. The expressions derived show how the total transmission and reflection of a medium containing the particles depends on the following variables: (1) index of refraction of the medium, (2) size and number of particles and their refractive index, (3) wave length of the incident light and its distribution, (4) absorption coefficient of the medium, and (5) thickness of the sheet. G.R.S.

Commercial glass transmitting ultra-violet light. P. DAVIDOVITCH. *Sprechsaal*, **64** [9], 173 (1931); for abstract see *Ceram. Abs.*, **10** [7], 490 (1931). M.V.K.

Structure of chilled glass. P. LAZAREV AND S. LIOSNYANSKAYA. *Compt. rend. acad. sci., U. S. S. R. Ser. A*, pp. 107–108 (1929); *Chem. Zentr.*, **I**, 630 (1930).—The decrease in density of chilled glass is studied from the surface to the center. When plates of chilled borax glass were ground so as to remove 58%, the specific gravity of the remaining part of the glass fell from 2.286 to 2.280 and n fell from 1.5170 to 1.5158. When 90% by weight was removed, n became 1.5151. The examination in polarized light yielded characteristic interference figures, which give a good illustration of the decrease in hardness. No change in specific gravity (2.284) was observed when the borax glass was cooled slowly. (*C.A.*)

Structure of glasses: evidence of X-ray diffraction. J. T. RANDALL, H. P. ROOKSBY, AND B. S. COOPER. *Jour. Soc. Glass Tech.*, **15** [57], 54–57 (1931).—A discussion is

given on a paper which appeared in *Jour. Soc. Glass Tech.*, 1930. For abstract see *Ceram. Abs.*, **9** [11], 926 (1930). G.R.S.

Sulphuric acid content of plate glass during the melting process. H. SALMANG AND A. MERTON. *Glastech. Ber.*, **9** [3], 148–51 (1931).—Former investigations of the sulphate content of glass during the firing process have been carried out only on a small scale to determine the connection between the SO_3 content with temperature, time of firing, and atmosphere of the furnace. The present investigation is carried out using 900 liter pots out of a pot furnace containing 16 pots of a glass of the following batch: 300 sand, 102 limestone, 100 sodium sulphate, 13 soda, and 5.5 carbon. Every half hour samples of glass have been drawn and simultaneously the atmosphere of the furnace has been analyzed and the temperature recorded. The SO_3 content of the glass in the average sample was at the beginning of the firing process 0.7%, after 3 hours 0.47%, and at the end (about 22 hours) 0.54%. The gas analysis shows the presence of both oxygen and carbon monoxide (incomplete mixture of air and gas). The furnace atmosphere can be considered neutral. Pots at the sides of the furnace show a higher percentage of oxygen. The carbon in the batch produces dissociation of the sulphate. During the firing process the SO_3 content remains almost constant, diminishing through thermic dissociation under the influence of SiO_2. The SO_3 content of glass does not influence the corrosiveness of the glass as has been shown by special experiments, the loss in weight of a soda glass being 0.44% and of the corresponding sulphate glass 0.42% (contrary to Keppeler's rule stating solubility of oxides in glass being proportional to their solubility in water). It was concluded that the sulphate is present in the glass as insoluble calcium sulphate. K.L.H.

Action of copper on glass pots. M. A. BESBORODOV AND M. F. SHUR. *Glashütte*, No. 6, pp. 90–91 (1931); *Tonind.-Ztg.*, **55** [20], 302 (1931).—Copper fragments found in glass pots had no action on the pots, but the glass in the immediate vicinity of the copper was red, that more distant was green, and the rest was colorless. Only the smallest copper particles were appreciably dissolved. The pots were made of different kinds of clays. M.V.K.

Composition theory of glasses. E. ZSCHIMMER. *Glastech. Ber.*, **8** [7], 385–93 (1930); *Diamant*, **52** [18], 289–90 (1930).—Comparisons of data found in clay tablets of Assyrians (700 B.C.) with present practice show very little change. A fixed formula was used instead of constant composition. The degree of sensitivity of properties is such that it is recommended that operators of large tanks think in terms of composition and not batch. The work of various investigators on variation of properties with variation in oxide composition is reviewed and discussed, much of it graphically. See also *Ceram. Abs.*, **10** [5], 334 (1931). E.J.V.

Practical experiences in ruby glass melting. WILHELM MEWES. *Keram. Rund.*, **39**, 20–22 (1931).—Lead-containing and lead-free compositions for gold ruby glass, lead rich, lead poor, and lead free compositions for copper ruby glass, and compositions for transparent and opaque selenium ruby glasses are given. Lead is usually a constituent in gold ruby glass since it reduces to half the amount of expensive gold required. Gold ruby glass is more easily made than copper or selenium since less care in melting is required to make a homogeneous and uniformly colored glass, the color is not easily fired out, and different shades may be more easily obtained. In copper ruby glasses, litharge may often be advantageously substituted for red lead. Reducing conditions must be maintained and test samples taken to ascertain that the proper ruby color can be developed on reheating. For selenium ruby glasses, at least a third of the alkali content must be K_2O to give brilliant colors; the lime content may not exceed 4% and ZnO must not be much greater; P_2O_5 as bone ash promotes color development; selenium as sodium salt shows less tendency to "fire out" than the element; at least twice as much

cadmium sulphide as selenium must be present. In order to prevent loss of selenium, melts must be made in closely covered pots or the selenium must be mixed with the reduction medium (tartar is given in the batch formula) and introduced at the second or third batch filling. H.I.

Use of an organic substance as an amber coloring medium for glass. S. GUSS. *Glashütte*, **60**, 389 (1930).—G. believes that the best, surest, and cheapest system for obtaining brown-colored glass is that which makes use of carbonaceous matter in conjunction with sulphate of soda. Owing to the liability of the carbon to burn out during melting, no hard and fast rule can be laid down for the formulation of the necessary batch proportions since all furnaces are not operated alike, and, moreover, the nature and composition of the fuel gas has a decided influence on the resultant melt. By studying each case individually it is possible to obtain and maintain any one of a range of color tints from dark brown through amber to golden-yellow. (*J.S.G.T.*)

Chemical causes of discoloration of glass exposed to sun and radium. JOSEPH HOFFMAN. *Sprechsaal*, **64** [17], 316–18 (1931).—(1) The ultra-violet rays of the sun cause discolorations in glasses as can be seen in the window glass of old buildings. These discolorations are destructible at low temperatures and can be regenerated by exposure to artificial ultra-violet light or radium. (2) The additional yellow tinge produced by sunlight in some glasses can hardly be dissolved out by colloidal sodium; on the contrary, silicate and boric acid glasses can be colored from yellow to brown by β and γ rays because of the destruction of sodium salts through discharged sodium ions or sodium atoms. (3) Gray coloring from exposure is traced back to different causes (heterogeneity of the amorphous phase, differences in the constituents of glass, destruction of quartz molecules, and coloring by colloidal silicon). (4) Discoloration from exposure depends in many cases on the coating or decolorizer used. Manganese and iron ions can produce it. (5) No harmony exists between the amethyst-like colorings of exposure of silicate and quartz glasses. The first are dissolved out by 3-valenced manganese ions and the latter by ferroferric ions. (6) Radium and ultra-violet rays act gradually on glass through the liberated electrons; they may be used as reagents on Mn (III)-ions (blue coloring, which gradually stabilizes into violet). (7) Green and brown bottle glasses are free from Mn (III)-ions, from which conclusions can be drawn concerning the combining of iron and manganese. M.V.K.

Decolorization of glasses. FRANK RUDOLF PESSERL. *Sprechsaal*, **64** [16], 298–99 (1931).—The influence of manganese, selenium, nickel, cobalt, and zinc oxide on the decoloration of glasses and an analysis of commercial decolorizers are given. M.V.K.

Dulling of plate glass. ANON. *Sprechsaal*, **64** [9], 167–68 (1931).—The dulling phenomenon on plate glass during storing, which is ascribed to the influence of moisture contained by air, is discussed. It is recommended not to store glass panes in cases as the evaporation from the surface of the panes takes place slowly and irregularly and the action of capillarity forces is strong. M.V.K.

Drilling holes in glass. H. SPURRIER. *Ceram. Ind.*, **16** [6], 553–54 (1931).—S. describes the method and technique of drilling holes up to about five-eighths of an inch in diameter in glass. The bit is made from a triangular file and the best lubricant to use is turpentine saturated with real camphor. The hole is drilled half way through from each side of the glass. For larger holes up to about 2 in., a piece of brass tube $^1/_{16}$ in. less in diameter than the size of the desired hole is fastened to a shank which fits the drill press chuck, and 120-mesh silicon carbide in water is used as the grinding medium, held in a reservoir formed by a zinc ring around the place where the hole is to be. The bit is revolved at about 120 r.p.m. A $1^1/_8$-in. hole is drilled through a $^7/_8$-in. thickness of glass in 44 minutes. Illustrated. W.W.M.

Testing safety glass. H. D. MURRAY AND D. A. SPENCER. *Ind. Chemist*, **6** [69],

399–401 (1930); *Sprechsaal*, **64** [9], 173 (1931).—A series of testing methods are given to determine the behavior of safety glass during breaking, boring, and pressing. The influence of heat and light on the color and behavior of glass in warm water must also be determined. M.V.K.

Manufacture of rolled plate. IX. Ernst Lutz. *Glass Ind.*, **12** [6], 128–31 (1931).—Considerable information regarding the comparison of single-chamber annealing kilns and leers as used in plate glass plants is presented. Data presented cover not only operating details, but economies in labor and fuel, etc. For Part VIII see *Ceram. Abs.*, **10** [7], 490 (1931). E.J.V.

Glass from blast-furnace slag by new process. C. A. Basore. *Rock Prod.*, **34** [11], 107 (1931).—B. has discovered a new process by which glass can be manufactured from slag refuse of blast furnaces and common building sand. W.W.M.

Fused silica. F. W. Preston. *Glass Ind.*, **12** [6], 132 (1931).—Taking into consideration the progress being made in the production of the 200-inch disk of fused silica and the fact that fused silica can do so many things better than glass, the question is raised whether it is not possible that fused silica may ultimately replace glass almost entirely. See also *Ceram. Abs.*, **10** [7], 490 (1931). E.J.V.

Researches on antique art glass. E. Berl. *Chem.-Ztg.*, **95**, 913 (1930); *Giorn. chim. ind. applicata*, **13** [1], 28 (1931).—The cause of the turbidity of some antique goblets of white glass showing fine surface cracks and scales was studied by Neumann. The analysis of several pieces showed that the chemical composition of these glasses has undergone changes during the many years that they have been buried in the ground. Part of the alkaline constituents have been removed by the action of solutions. It is possible that the devitrification was produced from another cause, *viz.*, the formation of crystals in the fused amorphous mass during manufacture, which, in developing, caused the turbidity. The phenomenon of anisotropy (by polariscope) is lacking in the scales as they are amorphous and regular. The formation of cracks on the surface of the glass may be regarded as the consequence of special tensions on the surface developed during manufacture. Covering antique glass objects with a protective coating is a method of preserving them and protecting them against the action of chemical agents. The surface tensions can be removed by heating the objects to a temperature at which the tensions disappear, and then carefully cooling them. M.V.K.

Research by British optical glass manufacturers. Chance Bros. & Co., Ltd. *Glass Ind.*, **12** [6], 133 (1931).—Results of recent research into the development of types of borosilicate glass for the manufacture of prisms in which the light absorption has been reduced to a remarkable extent are presented. The method of determining the light absorption is described. E.J.V.

How glass is made. Anon. *Bldg. Supply News*, **40** [6], 407–408 (1931).—The Pittsburgh plate process is described. E.C.C.

New uses for glass in the home. Anon. *Christian Sci. Mon.*, **23** [156], 11 (1931).—Among the newer uses for glass in the home are glass shelving, overmantels, table tops, doors, instead of tiling in a bathroom, for containers, and cooking utensils. Illustrated. E.J.V.

Mazda lamp bulbs. R. P. Brown. *Ceram. Ind.*, **16** [6], 530–32 (1931).—The various steps in the manufacture of lamp bulbs at the Pitney Glass Works, Cleveland, Ohio, are described. Two specially designed producer gas-fired regenerative type glass furnaces, each having a capacity of 200 tons, are employed. An asbestos conveyer carries the bulbs through the leer. The frosting process is described. Glass technology research laboratories are maintained. Machines used in the plant are assembled and installed under plant supervision. W.W.M.

Glass as building material. Walter Gropius. *Sprechsaal*, **64** [8], 149 (1931).—

The rapid development of the technique of glass manufacture has greatly increased the purity and quality of glass materials, and has made possible an extensive use of glass for buildings. M.V.K.

Homes of aluminum and glass. ALBERT FREY. *Popular Sci.*, **119** [1], 58 (1931).—New York architects vision the ultra-modern house as being built with aluminum walls and ultra-violet transmitting glass windows and skylights. Illustrated. E.J.V.

Details of new bottle machine by Lynch. LYNCH CORP. *Glass Ind.*, **12** [6], 119–24 (1931).—A detailed description is given of the new Lynch Model 10 machine and its operating principles are discussed. Illustrated. E.J.V.

Protest decreases in glass tariff. ANON. *Ceram. Ind.*, **16** [6], 543–44 (1931).—Some arguments for and against decreasing the tariff on cylinder, crown, and sheet glass are presented. W.W.M.

English crystal-glass industry. GEORGE A. MAKINSON. *Commerce Repts.*, No. 23, pp. 609–10 (1931).—Stourbridge and the surrounding villages in the extreme northern part of Worcestershire form the center of England's world famous crystal-glass industry. About 20 firms in the Birmingham district are at present engaged in the manufacture of crystal glassware, with practically all of it being handmade. Competition and general depression threatens the Stourbridge glass industry. The products manufactured in the Stourbridge district consist almost wholly of table crystal glassware of high quality, including clear, cut, ornamented, engraved, and colored articles. The U.S. is the principal market for exports. E.J.V.

New glass factory to be opened in Jugoslavia. STEWART E. MCMILLIN. *Commerce Repts.*, No. 21, p. 479 (1931).—A new glass factory, capitalized at about $475,350, financed by the Czechoslovakian and French capitals and to be known as the First Mechanical Glass Co. of Belgrade, is to be opened near Belgrade. Most of the Jugoslavian glass factories are owned by a cartel. E.J.V.

PATENTS

Melting glass, etc. HARRY F. HITNER. U. S. 18,071, May 19, 1931 (reissue). A tank wherein the substance acts as a resistor, comprising a metal electrode constituting one of the walls of the tank, and having an opening therethrough for the discharge of melted material, a second electrode at a point remote from the first electrode positioned so as to transmit current through the material in the tank at the point, and means for supplying electric current to the electrodes.

Making glassware. PIERRE ARBEIT. U. S. 1,805,796, May 19, 1931. (1) Glassworking apparatus comprising fluid pressure-actuated means for performing a plurality of glass-fabricating operations, a rotary distributor for receiving and distributing fluid pressure to the several fabricating means in predetermined order and time, and fluid pressure means operable in response to predetermined movements of certain of the fabricating means respectively for imparting predetermined intermittent step-by-step rotary movements to the distributor. (2) A glassworking machine comprising a carriage, a parison mold mounted thereon and adapted to be projected within a glass furnace to gather a charge of molten glass by suction from a glass bath therein, pneumatic means for determining the interval of time the mold remains in contact with the bath in the furnace, and a valve associated with the pneumatic means for varying the time interval.

Making protective glass with color wedge for spectacles. CARL GUSTAF BOSTRÖM. U. S. 1,805,969, May 19, 1931. An article of manufacture, comprising a pair of glass plates secured together by a colorless cement compound of uniform thickness and possessing approximately the same transparency and refractive index as the glass plates, and a color wedge embedded in the compound, the color wedge being com-

paratively dense at one end and gradually fading into transparency toward its opposite end.

Feeding molten glass. JOHN R. KELLER. U. S. 1,805,987, May 19, 1931. The method of producing mold charges of molten glass that comprises applying a variable centrifugal force to a descending body of glass to vary the rate of descent of different portions of the body of glass.

Manufacture of glassware. LÉON JEAN BROCHE. U. S. 1,806,445, May 19, 1931. In the manufacture of glass products, the step of severing a continuous product into lengths, which comprises advancing the material while hot upon a movable support and bringing a defined chilled area of the support intermittently into contact with the product to fracture the latter.

Feeding sheet glass to leer conveyers. MICHAEL FINCKE. U. S. 1,806,590, May 26, 1931. The combination with an intermittent sheet-glass forming machine, of a leer conveyer, having a feeding speed less than the speed of sheet formation, a take-off table reciprocable in the line of feed of the leer conveyer moving over the latter and receiving glass from the former, the table having means for feeding the glass from the forward end thereof onto the conveyer.

Distributing head for glassware forming machines. RUSSELL G. ALLEN. U. S. 1,806,731, May 26, 1931. A distributing head comprising, in combination, a stationary drum, a distributing ring surrounding the drum and having an annular passageway, the drum having a port opening into the passageway, means for rotating the ring, packing glands above and below the ring, and means for clamping the packing glands to the ring for rotation therewith.

Shear mechanism for glass feeders. ALBERT N. CRAMER. U. S. 1,806,743, May 26, 1931. A shear mechanism including a supporting frame, an air motor thereon having a reciprocating differential piston therein, a sleeve on the piston extending forwardly through one end of the motor cylinder, shears mounted on one end of the frame, adjustable connection between the shears and the sleeve carried by the piston, means to constantly apply air pressure to one side of the piston, means including a reversing valve for periodically applying air pressure to the opposite side of the piston, and automatic means directly controlled by reciprocation of the piston to reverse the air-pressure control valve at regular intervals.

Making composite glass. JOHN H. FOX. U. S. 1,806,846, May 26, 1931. A process of applying heat and pressure to a plurality of sheets of glass and reinforcing material which consists in placing the sheets in stacked relation between pressure members, causing such members to approach and apply compressive force to the set of sheets, and supplying high-frequency electric current to the members so as to induce molecular vibration in the sheets and heat them to the desired temperature.

Making composite glass. WILLIAM OWEN. U. S. 1,806,861, May 26, 1931. Apparatus for applying heat and pressure to a plurality of sheets to be joined together comprising a pair of opposing platens, each provided with an outwardly opening recess having a substantially flat rear wall and edge walls extending transversely of the rear wall to the faces of the platens, rubber containers seated in the recesses and supported at their edges by the edge walls of the recesses and adapted to receive between them the sheets to be joined, the edge walls being rounded outwardly, means for supplying liquid under pressure to the interior of the containers, and means for affecting predetermined temperature changes in the liquids.

Severing composite glass. WILLIAM OWEN. U. S. 1,806,862, May 26, 1931. A process of severing a composite glass plate comprising a pair of glass sheets with an interposed sheet of tough transparent material, which consists in simultaneously cutting slots completely through the glass sheets in opposition to each other, leaving a part at

least of the interposed sheet unsevered, and then separating the interposed material lying between the slots.

Treating glass articles. ROWLAND D. SMITH. U. S. 1,807,017, May 26, 1931. The method includes washing glass articles in water containing simple aluminium fluoride.

Making glass. HAROLD A. WADMAN. U. S. 1,807,054, May 26, 1931. The method of melting glass which comprises maintaining a supply of the batch adjacent a moving element, continuously moving the element to move a continuous sheet of glass batch into a melting zone, melting the batch to form glass, and delivering the glass into a glass bath.

Electrically heated container for molten glass. KARL E. PEILER. U. S. 1,807,071, May 26, 1931. Apparatus for feeding molten glass comprising a container having a discharge outlet, a cover plate for the container, heating means located in the container out of contact with the glass and adjacent to the cover plate, the heating means including refractory members provided with laterally extending channels in their upper surfaces, independently controlled electrical heating elements located in the channels for heating the glass at the discharge outlet, the cover plate being removable to permit access to the heating elements.

Glassware forming machine. JESSE H. TREECE. U. S. 1,807,095, May 26, 1931. The method which consists in causing a mold to traverse the surface of a supply body of molten glass, applying suction within the mold to the mold and a portion of the lower end thereof to fill the mold with glass and maintain sealing contact between the supply body of glass and mouth of the mold, lifting the mold out of contact with the supply body while maintaining application of vacuum to the cavity and bottom of the mold, discontinuing application of vacuum after the mold has been lifted and prior to moving beyond the supply body, and severing excess glass from the lower end of the mold.

Making glass articles. WILLIAM HOWARD SAID. U. S. 1,807,103, May 26, 1931. The method includes pressing molten glass in a mold, exerting fluid pressure on the glass in the mold, and ejecting excess glass from the mold against the pressure of the fluid.

Glass-gob disposing means. JEDDIAH B. CLARK. U. S. 1,807,336, May 26, 1931. In combination with a machine for making articles of pressed ware, having molds arranged in circular serial formation and carried rotatively about a vertical axis, plunger and pressing mechanisms for the molds, and a feeding means for separating mold charges from the source of supply at a distance above the mold, a disposer head having a funnel-shaped bore, there being a recess in the bottom of the head communicating with and flaring from the mouth of the bore, a frame disposed at position adjacent to the machine, a vertically reciprocable rocker member on the frame, a cross head swiveled on the forward end of the rocker member so as to operate in vertical alignment, a support rod retained adjustably, vertically, and rotatably in the cross head, and having an integral cross head thereon, a yoke member in which the disposer head is removably retained, the yoke member having an arm to be engaged in the cross head of the support rod, means to fasten the arm in the cross head of the support stem, means on the frame to limit the downward stroke of the forward portion of the rocker member, a counter-balance weight adjustable on the rearward portion of the rocker member, a spring on the frame to resist the force of the upward stroke of the rocker member, and a catch bar carried by the plunger mechanism of the machine, whereby with the completion of pressing and during the upward movement of the plunger-carrier mechanism, the disposer head is raised.

Manufacture of blown glassware. ROBERT W. CANFIELD. U. S. 1,807,566, May 26, 1931. (1) Apparatus for making blown glassware comprising a continuously rotatable support for a strip or ribbon of molten glass, the support having a plurality of down-

wardly opening orifices for the issue of glass from the strip, a plurality of blow molds rotatable with the support and each adapted to close beneath one of the orifices for enclosing glass issuing from the orifice, and means for blowing air through the orifice into the interior of the glass while the glass is enclosed in the mold. (2) Apparatus for shaping hollow glassware comprising a movable carrier, a plurality of glass-fabricating units removably mounted on the carrier, each unit including a parison support having an orifice provided therein, a blow head and an associated blow mold, and means for feeding a ribbon of glass upon the supports and in a position extending over a plurality of the orifices.

Floating bulb-edge glass trimmer. JOHN A. BOUSH. U. S. 1,807,619, June 2, 1931. In a device for cutting glass, a cutter, means for holding the cutter, means for yieldingly pressing the cutter against the glass, supporting means, the holding and the pressing means being carried by the supporting means, the holding means being movably carried by the supporting means to permit travel thereof both laterally and normally of the glass, spring means resisting lateral movement of the holding means away from the glass, and a stop limiting the travel of the holding means.

Glass-shaping machine. THOMAS COURTNEY MOORSHEAD. U. S. 1,807,857, June 2, 1931. A glass-shaping machine comprising a central vertical support, a frame carried by and rotatable about the support, means to rotate the frame continuously, blank mold-supporting arms pivoted to the frame, blank molds comprising separable parts carried by the arms, the arms and blank molds rotating continuously with the frame, means to move the supporting arms with the blank molds thereon so that at times the molds are rotating in an outer circle and in an upright position to receive a charge of glass and at other times are rotating in an inner circle, neck molds carried by the frame so as to move continuously in the inner circle, horizontal pivots carried by the frame, blow molds mounted for movement about the pivots, means to move the blow molds upward about the pivots to bring them into coöperation with the neck molds, a plurality of vertically movable register heads mounted on the frame, means for raising and lowering the register heads so that at times they serve to ensure proper alignment of the blank molds with the neck molds and at other times serve to ensure proper alignment of the blow molds with the neck molds, and pairs of locking members adapted to bind the parts of the blank molds together at the appropriate times by a jamming action.

Rolling sheet glass. JOSEPH A. REECE AND WILLIAM E. NOBBE. U. S. 1,807,873, June 2, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, a pair of rotatable sheet-forming rolls positioned thereabove and arranged to create a sheet-forming pass, and a pair of positively rotatable feeding rolls arranged beneath the forming rolls and disposed within the mass for supplying a relatively large body of glass to the sheet-forming pass partly under hydrostatic pressure and partly by a positive feeding action.

Handling glassware. JOHN E. SCHRODER. U. S. 1,808,180, June 2, 1931. Apparatus for handling glassware comprising an arm mounted for movement between a ware-receiving station and a ware-delivery station, a holder and tongs actuating means carried by the arm, tongs members mounted for vertical sliding movement with respect to the actuating means, means carried by the tongs for engagement with the ware and adapted to adjust the height of the tongs relative to the tong-engaging portion of the ware, and means for maintaining the ware-engaging means in a horizontal position whereby the ware-engaging portions of the tongs are maintained in horizontal alignment with each other, the tongs being frictionally maintained in their adjusted position during the transferring operation.

Multiple neck gage for bottles. CARL G. HILGENBERG. U. S. 1,808,955, June 9, 1931. A gage for inspecting bottles comprising a base having a plurality of recesses

of the shape and dimensions of the outer periphery of the bottle necks, and plugs disposed centrally of the recesses for gaging the openings in the necks, the recesses and plugs being spaced to correspond to the center distances of the bottles when inserted in the recesses and with adjacent bottles in contact.

Furnace. WILLIAM K. BROWNLEE AND MICHAEL J. OWENS. U. S. 1,809,105, June 9, 1931. A glass furnace comprising a melting chamber and a refining chamber separated by adjacent walls spaced to provide a passageway for the circulation of air, the walls extending downward beneath the floor level of the chambers, a water tank between the walls and also extending downward below the floor level, means providing a channel extending downward through the floor of the melting chamber, transversely beneath the walls and tank, and upwardly through the floor of the refining chamber, and refractory material interposed between the lower end of the water tank and the channel and forming the upper surface of the channel.

Manufacture of compound sheets of glass and cellulose derivative composition. WILLIAM JOHNSTON. U. S. 1,809,276, June 9, 1931. A process for effecting the interadherence of two sheets of glass to an interposed sheet of cellulose derivative composition, consisting in moistening the surface of the cellulose derivative composition sheet solely with a plasticizer of high boiling point, initially freely exposing and pressing together the glass sheets with the moistened cellulose derivative composition sheet interposed in a gas under pressure inert to the cellulose derivative composition sheet, and finally freely exposing and pressing the sheets in steam under pressure and at a temperature lower than the boiling point of the plasticizer.

Glass treatment. EDGAR D. TILLYER AND HAROLD R. MOULTON. U. S. 1,809,534, June 9, 1931. In a device of the character described, a block, a lens mounted on the block, a moving belt to carry the lens and block, a chamber to heat the lens when carried therethrough by the moving belt, a cooling blast adjacent the heating chamber under which the lens is carried by the moving belt to strengthen it, and a cooling chamber adjacent the blast adapted to receive the strengthened lens and slowly reduce it to its original temperature.

Glass feeder. THOMAS STENHOUSE. U. S. 1,809,794, June 9, 1931. (1) A glass feeder including a flow spout having a flow orifice, a pressure chamber associated with the flow orifice, an open-ended cylinder associated with and forming in effect an extension of the pressure chamber, and a piston reciprocable in the cylinder for producing variations in pressure in the pressure chamber to alternately accelerate and retard the flow of glass through the flow orifice. (2) A timing mechanism including a rotatable shaft, cams mounted on the shaft, guideways arranged concentrically of the shaft, a valve mounted for sliding movement in each of the guideways, and means for independently adjusting each valve in its guideway.

Glassforming machine. THOMAS AND DAVID STENHOUSE. U. S. 1,809,793, June 9, 1931. (1) In a glassforming machine, a continuously rotating table, a parison mold carried by the table, and a charge receiver in fixed relation with the mold, the receiver communicating with the lower end of the mold cavity and having an upwardly presented mouth. (2) In a glassforming machine, a mold and a single means movable to position to steady an article while the mold is being opened, and being further movable in substantially the same direction and in the same plane to eject an article after the mold is opened.

Shaping glass rods. EUSTACHIUS W. KOERING. U. S. 1,809,854, June 16, 1931. Apparatus for heating glass rods of large diameter without setting up disruptive strains therein, comprising a furnace having an opening in one side thereof for the exit of heat, and a rack for supporting the rods with the portion thereof to be heated adjacent the furnace, the rack having a guideway therein for permitting the rods to pass by gravity

from a position remote from the furnace opening to a position opposite thereto and means associated with the furnace for directing the heat on desired portions of the rods.

Making wire glass. ELISHA W. PAXTON. U. S. 1,809,863, June 16, 1931. Apparatus for making wire glass comprising an enclosure for supporting a glass pool having an opening for the escape of the glass, a pair of rolls coöperating with the opening to form sheet glass and a wire guide for feeding wire to the roll pass, the guide being shaped to coöperate with the rolls to control the flow of glass to the pass.

Glass-furnace charging apparatus. JOHN H. RITTER. U. S. 1,810,730, June 16, 1931. A glass-furnace charging apparatus adapted to prevent dusting, comprising a charge-carrying ladle having long and short side walls and a bottom forming an open top charge-receiving chamber of J-like cross-section, a shutter pivotally connected to the upper edge of the short side wall, and a shaft for supporting and rotating the ladle connected to an end thereof below the center of the end, the shutter being effective to retain the charge in the ladle until it is inverted and when inverted swinging downwardly and with the longer side wall coöperating with the surface of the molten glass to prevent spreading of dust in the furnace.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,810,736, June 16, 1931. The combination in a glass feeder of a container for molten glass having a bottom outlet opening, means to control issue of glass through the opening including a tube projecting into the glass over the opening, and means to supply heat to the interior of the tube to reheat portions of the glass in the container.

Cutting laminated sheet glass. B. L. GREGG. Brit. 346,697, April 29, 1931.

Making sheet glass. MISSISSIPPI GLASS CO. Brit. 346,927, April 29, 1931.

Machines for forming necks of glass bottles. G. E. AND H. A. BATESON. Brit. 346,941, April 29, 1931.

Splinterless glass. BRITISH CELANESE, LTD. Brit. 347,219, May 6, 1931.

Manufacture of glass bottles, etc. UNITED GLASS BOTTLE MFRS., LTD., AND T. C. MOORSHEAD. Brit. 347,365, May 6, 1931.

Feeding molten glass to a rolling apparatus for producing a continuous glass strip. PILKINGTON BROS., LTD., AND E. B. LE MARE. Brit. 347,584, May 13, 1931; PILKINGTON BROS., LTD., E. B. LE MARE, AND F. B. WALDRON. Brit. 347,585, May 13, 1931.

Glass-rolling apparatus particularly applicable to the production of continuous glass strip. PILKINGTON BROS., LTD., E. B. LE MARE, AND F. B. WALDRON. Brit. 347,586, May 13, 1931.

Glass-annealing leers. PILKINGTON BROS., LTD., AND E. B. LE MARE. Brit. 347,587, May 13, 1931.

Glass-rolling apparatus particularly applicable to the production of continuous glass strip. PILKINGTON BROS., LTD., AND F. B. WALDRON. Brit. 347,588, May 13, 1931; PILKINGTON BROS., LTD., AND E. B. LE MARE. Brit. 347,589, May 13, 1931.

Manufacture of reinforced glass. BRITISH CELANESE, LTD. Brit. 347,777, May 13, 1931.

Manufacture of splinterless glass. BRITISH CELANESE, LTD. Brit. 347,972, May 13, 1931.

Manufacture of glass sheets. CHANCE BROS. & CO., LTD., AND A. L. FORSTER. Brit. 348,291, May 20, 1931.

Leers, furnaces, etc., for annealing glassware. UNITED GLASS BOTTLE MFRS., LTD., F. A. HURLBUT, AND W. A. MOORSHEAD. Brit. 348,354, May 20, 1931.

Severing glass articles from a glass ribbon. A. E. MELHUISH. Brit. 348,376, May 20, 1931.

Leers for glassware. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 348,481, May 20, 1931.

Glass permeable to ultra-violet rays. FRITZ AND RICHARD WOLLNER AND FERDINAND NIKOLAI. Austrian 120,674, Oct. 15, 1929; Fr. 691,805, March 12, 1930; for abstract see *Ceram. Abs.*, **10** [5], 345 (1931). (*C.A.*)

Reinforced glass. SOC. DES USINES CHIMIQUES RHÔNE-POULENC. Fr. 37,119, June 22, 1929. The compound sheets of glass are heated without pressure to a temperature above the ordinary after removal from the bath of plastifying material. See also *Ceram. Abs.*, **10** [6], 425 (1931). (*C.A.*)

Safety glass. I. G. FARBENIND. A.-G. Fr. 695,330, May 8, 1930. A layer or layers of esters of polyvinyl alcohol such as polyvinyl acetate is interposed between 2 or more layers of glass. (*C.A.*)

Safety glass. ROBERT P. F. V. HAMOIR. Fr. 696,787, Sept. 16, 1929. Safety glass is made with sheets of glass united by a layer of transparent or translucid synthetic resins, particularly by-products having a basis of urea-CH_2O. (*C.A.*)

Apparatus for tempering glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Fr. 696,819, Sept. 21, 1929; see also *Ceram. Abs.*, **10** [7], 499 (1931). (*C.A.*)

Apparatus for feeding molten glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Fr. 697,054, June 2, 1930. (*C.A.*)

Production of large glass vessels. C. PHILIPP. Ger. 501,506, June 4, 1927. Large glass cylindrical or prismatic-shaped vessels are made by pressing the base by means of a flat plate on the end of a handle and drawing the sides from the excess glass pressed out between the mold and the sides of a drawing member adjustably mounted on the handle. (*J.S.G.T.*)

Arrangement of rolls for producing sheet glass. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 503,228, Feb. 1, 1928. In an arrangement for rolling molten glass into sheets whereby the glass is tipped from a pot into the space formed by the sizing rolls and a retaining wall resting on a bottom portion, the axis of the upper sizing roll being capable of radial motion about that of the bottom roll, the retaining wall is coupled to the axis of the upper roll by coupling rods at either side so that it follows the motion of the latter. (*J.S.G.T.*)

Forming solid glass articles by rolling. R. BERGMANN AND R. FUNCKE. Ger. 503,229, Nov. 13, 1927. Glass in the form of rods is fed to a chute-like holder so that the rods fall in turn down a slot in the base passing through a melting compartment where they are softened at the end protruding from the slot and drawn off by the rolls without any congestion or sticking of the rods in the melting chamber. See also *Ceram. Abs.*, **9** [5], 348 (1930). (*J.S.G.T.*)

Rolls for sheet-glass leers. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 503,232, Dec. 9, 1927. The bearers for the hollow cylindrical rolls that support the glass sheet are so made that they give extra support to the middle part of the roll span in order to prevent sagging of the latter and consequent deformation of the sheet. (*J.S.G.T.*)

Spectacle lens cutting machine. NITSCHE & GÜNTHER OPTISCHE WERKE A.-G. Ger. 503,233, Oct. 23, 1928. The blank is fastened to a vertical spindle carrying a series of templates of suitable but different profile and selection is made by sliding a rigid finger along a fixed vertical bar. Rotation of the spindle causes a fixed diamond to make a scratch on the blank following the selected profile. (*J.S.G.T.*)

Lens cutting machine. NITSCHE & GÜNTHER OPTISCHE WERKE A.-G. Ger. 503,234, Nov. 6, 1929. In a machine for cutting out lens blanks comprising a set of

templates arranged on the axis of the cutting table or on one parallel thereto which are pressed against an arm by a spring-actuated pin, a compensating template of similar form to that being used and mounted in a similar fashion but displaced 90° with reference to it is employed to exert a compensating pressure on the arm and so ensure a uniform motion of the machine. (*J.S.G.T.*)

Cooling shears on suction machines. J. WALKER & SONS, LTD. Ger. 503,844, Sept. 4, 1927. In a machine of the Redfern type, air-cooling ducts are provided to discharge between the shear spindle and its housing and into the bottom bearing of the shaft so that the air cools the immediate neighborhood. (*J.S.G.T.*)

Production of clear bubble-free fused quartz. SOC. ANON. QUARTZ ET SILICE. Ger. 504,132, Feb. 29, 1928. The melting space is packed as fully as possible with pieces and the intervening spaces are filled in with fine quartz sand to prevent slipping. After fusion the mass is broken apart and the clear portions are selected for further treatment. (*J.S.G.T.*)

Movement of glass sheets through the leer. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 504,555, July 23, 1927. A device for intermittently moving the glass through the leer consists of a system of raising, lowering, and displacing devices within the leer controlled and driven from without through coupling devices situated beneath the furnace floor. (*J.S.G.T.*)

Feeding molten glass. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G. M. B. H. Ger. 504,694, July 11, 1920. The glass issuing from an aperture in the bottom of the container is caught and held in a retaining cup and discharged therefrom to the mold in a shape better adapted to fill the latter. (*J.S.G.T.*)

Discharging charges of molten glass from a container. DEUTSCHER VERBAND DER FLASCHENFABRIKEN G. M. B. H. Ger. 504,695, July 1, 1923. In a feeding process whereby molten glass is discharged from an orifice in the bottom of a container by air pressure, the glass is throttled where entering the orifice, giving a better discharge. The glass passes from the orifice to a retaining cup as described in the preceding patent. (*J.S.G.T.*)

Continuous production of sheet glass by rolling. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Ger. 504,778, Sept. 25, 1925. In a process whereby molten glass passes through a slit in the side wall of a tank furnace below the level of the glass inside and forms a pool feeding a pair of sizing rolls placed near the wall, the height of the pool is maintained below that of the glass in the tank by the surface tension of the glass, suitable adjustment of the speed of rolling, the separation between the rolls and the wall, and the size of the slit. See also *Ceram. Abs.*, **7** [10], 686 (1928). (*J.S.G.T.*)

Stopper grinding device. J. ROLKE G. M. B. H. Ger. 505,297, Jan. 15, 1930. The work is gripped between eccentrically mounted disks which are suspended elastically above the stopper being ground in so that the vibrating, up and down motion assists the grinding operation. (*J.S.G.T.*)

Fusible low expansion glass for electrical use. SOC. LA RADIOTECHNIQUE. Ger. 505,782, Sept. 22, 1926. The composition disclosed is boric acid and soda in the ratio of 85:15 with silica less than 75% of the total batch. (*J.S.G.T.*)

Skimming device for gathering from forehearth. BULLMAN MACHINE CO., LTD. Ger. 506,382, June 29, 1928. In a skimming device to clean the surface of the glass in a forehearth preparatory to gathering therefrom by suction, the substantially vertical skimming blade moving across the horizontal surface of the glass is provided with a bottom portion so bent toward the horizontal plane that it accelerates the skimming action. (*J.S.G.T.*)

Production of figured glass. MÜHLIG-UNION GLASINDUSTRIE A.-G. Ger. 506,385,

March 3, 1928. The cooling water is introduced into the roller, impressing the pattern by means of a tube which forms its axis, which is cranked at either end before passing through bearing blocks so that the roller has a swinging moment about the blocks. (*J.S.G.T.*)

Feeding sheet glass from the rolls to the leer. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 506,387, April 8, 1928. In a process whereby rolled sheet or plate glass is received upon rollers on a movable carriage and fed therefrom into the leer, the rollers of the carriage are driven with a peripheral speed equal to that of the rollers in the leer, and the carriage itself is fed toward the leer with a velocity equal to the difference between that of rolling the sheet and of feeding it through the leer. (*J.S.G.T.*)

Movement of glass sheets through the leer. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 506,388, April 21, 1928. The receiving end of the leer is enlarged to house on either side of the main roller-lined track a similar, subsidiary track receiving the sheet glass from the rolling plant associated with it, so that while one track is feeding its sheet into the leer, the other is receiving a sheet from the rolls. (*J.S.G.T.*)

Cam tracks for automatic glassblowing machines. J. WALKER & SONS, LTD. Ger. 506,470, Sept. 15, 1927. In a machine in which a plurality of mechanically operated molds revolve around a central pillar and are actuated by rollers moving on cam tracks, the cam tracks are capable of movement for adjusting independently of the rotation of the machine. (*J.S.G.T.*)

Facilitating pouring of glass from pots. M. BICHEROUX. Ger. 506,471, Aug. 29, 1926. Where auxiliary rollers are used to form retaining boundaries in the casting process for producing sheet glass, the rollers are capable of axial displacement about the sizing rolls or in other directions, either individually or together. (*J.S.G.T.*)

Cutting spectacle lenses. NITSCHE & GÜNTHER OPTISCHE WERKE A.-G. Ger. 506,473, Nov. 6, 1929. In a machine for cutting out lens blanks consisting of a cutting tool working in conjunction with a master template, means are provided to ensure that the guiding member follows the profile of the latter. (*J.S.G.T.*)

Conveying rolls for leers. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 506,672, May 17, 1928. In an arrangement for feeding sheet glass through the leer by rollers which consists of an inner, cooled roller proper carrying an outer cylindrical shell which makes contact with the glass, the shell is connected with the roller only at a few small isolated points on its surface in order to reduce the transfer of heat. See also *Ceram. Abs.*, **8** [8], 578 (1929). (*J.S.G.T.*)

Production of articles of fused quartz. SOC. ANON. QUARTZ ET SILICE. Ger. 507,079, Feb. 16, 1927. In a process for heating preformed hollow quartz articles embedded in quartz sand to prevent deformation, only certain predetermined portions of the hollow articles and the sand about them are heated, *e.g.*, in the production of a flange or foot on the end of a tube. See also *Ceram. Abs.*, **10** [6], 426 (1931). (*J.S.G.T.*)

Glassmelting furnaces. HARTFORD-EMPIRE CO. Ger. 514,527, April 3, 1927. Details of construction are given. See also *Ceram. Abs.*, **7** [1], 24 (1928). (*C.A.*)

Glass. HERZOGENRATHER GLASWERKE BICHEROUX & CIE G.M.B.H. Ger. 514,609, Nov. 7, 1926. Rollers for rolling out molten glass are cooled by a liquid having a boiling point higher than 100°. (*C.A.*)

Compound glass. GEORGE E. HEYL AND MORRIS GREENHILL. Ger. 519,028, Aug. 30, 1928. A sheet of cellulose acetate or other cellulose derivative is interposed, while immersed in a softening liquid such as triacetin, between two glass sheets, and the

resulting compound sheet is pressed, rolled, and finally united by steam pressure. The edges of the sheet may be treated with rubber solution before the steam treatment. See also *Ceram. Abs.*, **8** [9], 653; [12], 881 (1929). (*C.A.*)

Plant for cutting plate glass in plastic state. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 519,477, Oct. 4, 1928. (*C.A.*)

Roll-conveyer leer for intermittently rolled plate glass. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 521,298, May 11, 1930. (*C.A.*)

Apparatus for conveying intermittently rolled plate glass to a number of leers. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Ger. 521,299, Feb. 5, 1929. (*C.A.*)

Structural Clay Products

Factors affecting the strength of masonry of hollow units. DOUGLAS E. PARSONS. Research Paper No. 310; Bur. Stand., *Jour. Research*, **6** [5], 857–67 (1931).—A study was made of the data reported in Univ. of Ill., *Bull.*, No. 27 and the Bur. Stand., *Tech. Papers*, Nos. 238 and 311 to determine the importance of some of the factors affecting the strength of masonry of hollow units. For end-construction walls a simple empirical equation is found to express the relation between strength of walls and certain easily determined properties. For both end and side construction, the geometrical properties of the units appear to have an important effect, and the strength of the units is not a close measure of the effect of their characteristics on the strength of the walls. R.A.H.

Progress in the manufacture of hollow brick. ALFRED HIELSCHER. *Tonind.-Ztg.*, **55** [26], 379–82; [29], 420–23 (1931).—The latest types of light brick (porous and hollow brick) and methods of manufacture are described. M.V.K.

Hollow brick closed on five sides. ANON. *Tonind.-Ztg.*, **55** [39], 577–79 (1931).—A machine which produces five-sided brick is described. Drying may be done in the air or in artificial driers. W.M.C.

Effects of body composition and firing treatment on salt glazes. R. K. HURSH AND E. C. CLEMENS. *Jour. Amer. Ceram. Soc.*, **14** [7], 482–89 (1931).

Klinker brick manufacture. ANON. *Brit. Clayworker*, **40** [468], 14–17 (1931).—The types of brick made in England and America, which in some measure approach the Klinker brick of Germany, are the brown hard-fired engineering brick made in the West of England, North Wales, and in Yorkshire, and the vitrified road-paving brick of America. The effects of color play and surface in these brick arise entirely from the composition of the clay and its treatment in the kiln. They are dependent on the presence in the clay of suitable fluxes, iron oxide, and quartz sand and, furthermore, artificial mixtures are not found to react to the manufacturer's treatment like the natural material. A characteristic analysis of a superior Klinker-brick clay is as follows: Al_2O_3 13.67%, SiO_2 70.22%, Fe_2O_3 6.80%, CaO trace, MgO 1.30%, alkalis 3.37%, and loss on ignition 5.30%. Whatever mixture may be tried, it is essential that research be made to ascertain the difference in temperature between the sintering and the fluxing or squatting points. If these are too close together it is not possible to succeed in producing the "vitrified" brick desired. In the manufacture of Klinker brick the preparation of the clay is of prime importance. Intimate mixing is important, accuracy of proportions is essential, and fine grinding by high-speed finishing rolls is indispensable. The method of drying and firing the brick and different types of kilns which may be

used are discussed. The firing temperature should be about 1200°C corresponding to Seger cone 6*a*. R.A.H.

Results of freezing and thawing tests on sand-lime brick. H. F. McMURDIE. *Rock Prod.*, **34** [12], 53–58 (1931).—In order to determine the importance of absorption requirements in specifications for sand-lime brick as a measure of weather resistance, 22 sets of 10 half-brick each, having various absorption properties previously determined, were subjected to 50 alternate cycles of freezing and thawing. No apparent relation was found to exist between the amount of absorption and the resistance to freezing and thawing. It was found, however, that a brick having both a fast rate of absorption in partial immersion and a high strength was likely to withstand freezing and thawing satisfactorily. Those brick which withstood the tests were found to have increased compressive strengths. There is no reason for continuing the requirement as to total absorption in specifications for sand-lime brick. The use of a requirement as to rate of absorption might well be considered. W.W.M.

New sand-lime brick patents. T. THAMM. *Tonind.-Ztg.*, **55** [18], 261–62 (1931).—New methods of manufacturing sand-lime brick from calcareous sandstone and from clay marl, a process of manufacturing perforated sand-lime brick, a method of hardening and water-proofing sand-lime brick, and new types of rapid fasteners for pressure boilers are discussed. M.V.K.

Ice formations on brick. ANON. *Tonind.-Ztg.*, **55** [33], 490 (1931).—Observations during a period of bad weather showed that small differences in the structure of brick influence the distribution of moisture. On a northwest wall made of "Fletton" brick, ice spots were observed after a cold wind. These ice spots were found on the darker marks on the brick only. The dark marks were where the brick had been in contact with other brick during firing. These ice places were scratched with a needle to be more discernible on the photographic plate. No traces of ice were found on the clinker in the same wall. This showed that the water was not formed by precipitation from the air but originated from the brick itself. It was also found that efflorescences were mainly on these dark marks. This distribution of water in definite places on a material which was homogeneous before firing must be ascribed to differences in the capillarity of the material, influences of temperature, and differences in the reflecting power of surfaces to radiation. Investigations of the brick showed that the body was finely porous on the dark marks and often more dense than the other parts of the brick. These finely porous places remained saturated with water during drying because they absorbed water from the other part of the brick, thus producing an irregular distribution of water. In freezing weather an ice layer was formed on these dark places saturated with water. Salts were also concentrated in these places and formed efflorescences. Although the explanation of the phenomena observed seems to be correct, differences in the reflecting power of surfaces for infra-red radiation were determined and showed an irregular distribution of temperature on the surface. A wall of Fletton brick laid with finely porous mortar was saturated at the bottom with a special salt solution. Neither efflorescences nor ice were formed on the brick although both phenomena appeared visibly on an adjacent wall at the same time. The mortar which apparently had absorbed most of the water was considerably disintegrated. M.V.K.

Brick fillers and bedding courses. P. HUBBARD. *Can. Eng.*, **60** [18], 50 (1931).—Given a reasonably uniform joint space with a minimum width of $^3/_{16}$ in., it is believed that two types of asphalt filler will be found satisfactory. For a poured joint filler, an oxidized asphalt with a somewhat higher minimum melting point than is now permitted should be used. For a squeegee filler, an asphalt grout composed of a mixture of steam-refined asphalt and sand, similar to that now commonly used in the construction of granite block pavements, should prove satisfactory. G.R.S.

Colored plaster buildings. ANON. *Tonind.-Ztg.*, **55** [40], 585–87 (1931).—Coloring of buildings may be done by introducing colors into the mortar (lime or cement mortar). A chart is given of different substances to get different colors. W.M.C.

Penetration of dampness into houses built of hard-fired brick. SCHAEFER. *Tonind.-Ztg.*, **55** [38], 553–56 (1931).—The reason for penetration of dampness into houses built of hard-fired brick is often the use of inferior mortar for the construction of houses. Some further information is given as well as a review of different means to avoid the trouble encountered, the main topic being selection of raw materials and exact mason work. W.M.C.

Technical problems of hard-fired brick. DIECKMANN. *Tonind.-Ztg.*, **55** [36], 521–22 (1931).—Some general remarks are given as to building with hard-fired brick. It is possible to make a building entirely waterproof with this material. W.M.C.

Waterproofing masonry walls. H. SPURRIER. *Brick Clay Rec.*, **78** [11], 587–89 (1931).—If attention is paid to maximum density grading of materials the water absorption of finished products will be lowered. Tests show that repeated freezings of porous bodies saturated with water result in increased porosity and permeability until the bodies break down. Some tests on commercial mortar waterproofing materials are described and the results obtained discussed. Illustrated. E.J.V.

Material for cleaning scum from brick walls. ANTI-HYDRO WATERPROOFING CO. *Brick Clay Rec.*, **78** [10], 556 (1931).—Anti-Hydro is a damp-proofing material which, when added to Portland cement mortars used in masonry construction, is said to prevent effloresecence from that source. Its various properties and advantages of its use are enumerated. E.J.V.

Defects in the manufacture of wire-cut brick. ANON. *Tonind.-Ztg.*, **55** [20], 290 (1931).—The causes of jagged edges, notches, and fissures in the edges of the pressed clay as it emerges from the mouthpiece are explained and ways of remedying the defects suggested. M.V.K.

Soft-mud machinery. II. ELIAS PETTS. *Brick Clay Rec.*, **78** [11], 598–99 (1931).—P. discusses the duties of the soft-mud brickmaker and his three helpers, the bumper, the dumper, and the pallet boy, as was the practice fifty years ago. Some of the many changes that were introduced in the development of soft-mud machinery are enumerated and explained. Illustrated. For Part I see *Ceram. Abs.*, **10** [7], 502 (1931). E.J.V.

Handle brick with mechanical grab. ANON. *Brick Clay Rec.*, **78** [11], 581 (1931).—A description of the Neumann Brick Grab, the invention of Carl Franz Neumann, Hamburg, Germany, which follows in its mechanical principle the action of a pair of ice tongs, is presented. Illustrated. E.J.V.

Prevent floods with clay block on drainage project. ANON. *Brick Clay Rec.*, **78** [10], 535–37 (1931).—A special tongue and groove clay unit was developed for use in paving the main drainage facility in Galesburg, Ill., thus improving its ability to cope with the drainage of concentrated volumes of water which formerly had caused destructive floods. Illustrated. E.J.V.

Practical test for reinforced brickwork. ANON. *Brick Clay Rec.*, **78** [10], 532–34 (1931).—The first major structures of reinforced brickwork to be erected in this country are sand storage bins, one of which is 25 ft. 1 in. in diameter and the other 16 ft. $2^1/_2$ in., and both of which will rise to a height of 52 ft., being built by the Wedron Silica Co., Wedron, Ill. Full description of construction details, etc., is given. Illustrated. E.J.V.

Reinforced brick masonry. MAJOR L. B. LENT. *Jour. Amer. Ceram. Soc.*, **14** [7], 469–81 (1931).

Reinforced brick masonry. JUDSON VOGDES. *Clay-Worker*, **95** [5], 348–49

(1931).—A brief historical sketch is presented of the use of reinforced brickwork from the efforts of Sir Marc Brunel in 1838 down to the present day when it is being studied rather extensively in the U.S. See also *Ceram. Abs.*, **10** [5], 349 (1931). E.J.V.

Brick road. FERNAND WATTEBLED AND FED. CARINI. *Rev. mat. constr. trav. pub.*, No. 259, pp. 75–77*B* (1931).—In a study of tests for paving brick three general points are considered: (1) the physical and chemical nature of the materials, (2) the destructive action resisted by brick surfacing, and (3) standard tests for determining the characteristics of usage. Tests used in Holland are listed. M.Y.H.

Coating with brick. ANON. *Brick Clay Rec.*, **78** [10], 541 (1931).—The field for home modernization work, such as "overcoating" homes with brick, is discussed. Some cases of modernizing stucco by this method are illustrated. E.J.V.

Hy-tex brick. H. F. WILLIAMS. *Clay-Worker*, **95** [5], 333–36 (1931).—Eight well-known New York buildings, in which the harmony of design and color was obtained by the use of face brick, used about 20,000,000 Hy-tex brick, a product of the Hydraulic Press Brick Co., St. Louis, Mo. Illustrated. E.J.V.

Contest to stimulate face-brick sales. ANON. *Bldg. Supply News*, **40** [6], 408 (1931). E.C.C.

Attractiveness of clay products. ANON. *Brick Clay Rec.*, **78** [10], 540–41 (1931).—As evidence that clay products have the "something different," architects have been demanding their use in some of the newer large buildings, such as the Empire State Building, New York. Illustrated. E.J.V.

Ancient brick used for modern construction. ANON. *Tonind.-Ztg.*, **55** [21], 314 (1931).—Large quantities of brick over 3500 years old, recently found in Mesopotamia, are being utilized for the construction of a new railway station there. M.V.K.

BOOKS

Story of Brick Construction and the German Art of Brickmaking. (Kurze Geschichte des Ziegelbaues und Geschichte der deutschen Ziegelbaukunst bis das zwölfte Jahrhundert.) RICH. HAUPT. Heide in Holstein. 148 pp., 72 illustrations. Rm. 5.50. Reviewed in *Tonind.-Ztg.*, **55** [25], 376 (1931). M.V.K.

Building Materials Guide. (Der Baustoffführer.) E. PROBST. 2nd ed. C. Marhold, Halle (Saale). 329 pp. Rm. 6.00. Reviewed in *Tonind.-Ztg.*, **55** [22], 335 (1931).—This is the new and enlarged edition of the technical guide to natural and artificial building materials. M.V.K.

PATENTS

Connecting means for conduit. EDWIN BABB. U. S. 1,807,647, June 2, 1931. As a manufacture, means for connecting a conduit with a plurality of conduits extending therefrom comprising a unitary member having a portion of its wall cut away and at least one coöperating member having a portion adapted to enter the space provided by the cut-away portion and abut the wall adjacent thereto.

Texturing brick. J. ERROL SMITH. U. S. 1,809,572, June 9, 1931. A texturing apparatus for a plastic column, etc., including opposed cutters having radial blades and mounted upon axes perpendicular to opposite side surfaces of the column, and means for rotating the cutters upon their axes.

Manufacture or firing of brick, etc., and fuel for use therewith. J. ONIONS. Brit. 347,266, May 6, 1931.

Machine or apparatus for laying composition, such as mortar for brick. J. W. KAVANAGH. Brit. 347,309, May 6, 1931.

Manufacture of brick, etc. T. JONES, R. BARKER, AND D. C. MURRAY. Brit. 347,845, May 13, 1931.

Brick laying machine. W. H. MASSEN. Brit. 348,052, May 20, 1931.

Brick. FRANCO BANDINI. Austrian 120,972, Aug. 15, 1930. Clay containing at least 20% of water is warmed to about 95° and molded in a press maintained at the same temperature. The brick are dried at once in a moist atmosphere in an oven in which the temperature is initially the same as that of the brick, but is gradually raised. (*C.A.*)

Refractories

Heat transfer through refractory materials. HANS ESSER, HERMAN SALMANG, AND MAX SCHMIDT-ERNSTHAUSEN. *Sprechsaal*, **64** [7], 127–29; [8], 145–48; [9], 165–67; [10], 187–89; [11], 205–208 (1931).—(1) A new method for determining the thermal conductivity of poor solid conductors is described. Special features of the method are higher temperature range, limited testing time, and availability of finished blocks. The tests were made under uniform thermal conditions and the thermal figures result from measurements on a calorimeter of the time and quantity of heat, and temperature and longitude measurements on the testing body. The samples investigated were hollow cylinders with an outside diameter of 40 mm. (2) Unlike the hollow-cylinder method, calorimetric energy and "outside heating" were used in this case where the heat penetrates the outside cylinder shell of the sample and the heat current obtained in the heating tube radiates through the body from outside into inside. The amount of heat leaving the inside of the body is calorimetrically measured. The measurements are made in the middle zone of the radial heat stream on a stretch 60 mm. long, with the total length of the body equal to 300 mm. and the length of the heated kiln, 320 mm. Water is used as the liquid and its temperature increase measured electrically by a galvanometer. The measurement of time and quantity of water is made volumetrically. A precision millivoltmeter is used for determining temperature and temperature differences. (3) On the basis of a critical review of known methods, points to be observed for determining conductivity are discussed. In the method described, the mathematical values, the development of constructive details, the sources of error, and the exactness of measuring are given. The method permits the use of prepared and fired masses and finished blocks for determining conductivity. The preparation of a sample from finished blocks takes 1 to 2 hr.; determining a temperature value of thermal conductivity requires 3 to 4 hr. (4) The highest temperatures obtainable by the size of the body used lie near 1200°C corresponding to the average conductivity figures of 1050 to 1100°. (5) The average exactness of measurements varies between 5 to 8% corresponding to the temperatures used and materials investigated. The error rising from the geometrical measurements is important here. Heat is lost because of the use of central-zone measuring. The diameter of the testing body was small in order to shorten the tests and to permit the measurement of technical blocks. (6) The temperature field and exactness of measurements can be changed by increasing the size of the bodies. (7) The dependence of heat conductivity on the chemical composition and the physical behavior of refractory materials was investigated on grog and silica blocks. A critical review of the latest facts on heat conductivity of refractory materials, especially of grog and silica blocks, is given. The object of the researches was to ascertain the influence of the size of pores with equal porosity and firing temperature on the conductivity of bodies of uniform chemical composition at high temperatures. (8) By varying the grain size, 2 testing series are formed in which the size of pores is the only variable. The preparation of series of tests is described and the results discussed. Conclusions may be drawn with regard to the influence of the size of pores and porosity. The position of the conductivity curve of a refractory material with a constant chemical

composition is conclusively determined in the conductivity-temperature diagram by the porosity. On the other hand, its ascent, depending on the temperature with definite porosity and definite chemical composition, is an important function of the size of pores. (9) A series of tests to ascertain the influence of firing temperature showed that with increased firing temperature the conductivity increased. (10) Further researches were made on 22 technical grog and silica blocks. The controlling influence of porosity is especially evident in grog blocks as the porosity in these blocks varies within greater limits. Owing to a completely irregular grain size in standard technical blocks and irregular firing temperature, the influence of the size of pores on the conductivity figures is obscure. Because of the heterogeneity of their physical structure, the influence of the alumina content of blocks is not entirely clear. Nevertheless, a remarkable increase of thermal conductivity with an increased Al_2O_3 content was determined. (11) Silica blocks possess, on the average, higher thermal figures and more precipitous conductivity curves. (12) The numerical values show that a higher thermal conductivity is obtained effectively by using substances as dense as possible. This concerns silica and grog blocks especially as in these blocks the dense material contains a positive temperature coefficient. The other way of obtaining very precipitous conductivity curves by large-sized pores with higher porosity is less efficient because an abnormally high diameter of pores would be required. (13) Ways by which the highest isolating action at high temperatures can be obtained are evident from investigations on the influence of the size of pores. M.V.K.

Influence of sharp temperature fluctuations on ceramic products. V. SKOLA. *Keramik*, Vol. 10, pp. 251–61 (1930); *Sprechsaal*, **64** [18], 337 (1931).—The method worked out by S. for determining the sensitiveness of ceramic products to temperature changes is described. Similar samples are prepared from the material to be investigated (6 from a standard brick), are ground parallel, and are carefully measured. The surfaces are microscopically investigated and defective places removed. To learn the homogeneity of the material, the porosity of separate samples is determined. The resistance to pressure is determined on one part of the test piece, and the other samples are heated to a definite temperature in a kiln for a certain length of time, then cooled in cold water and tested for their resistance to pressure. This procedure is repeated several times until the resistance to pressure of the samples is decreased. With especially sensitive thermic material, the kind of cooling may vary, *viz.*, hot water, oil, or cold air. Valuable conclusions may be drawn on the capability of resistance of ceramic bodies to temperature changes from the course of decrease of the resistance to pressure. Concerning the exactness of the method, the average error of 6% was determined on a grog brick cut into 6 pieces. Similar methods of testing [Goodrich (*Ceram. Abs.*, **6** [11], 522 (1927)) and Parmelee and Westman (*ibid.*, **7** [4], 235 (1928))] are discussed and their advantages and disadvantages pointed out. M.V.K.

Heat conductivity of refractories. ANON. *Tonind.-Ztg.*, **55** [33], 484 (1931).—Heat conductivity of refractory materials depends on the chemical composition, structure, porosity, and previous treatment of blocks. Firing temperature and duration of heating may also influence it. With the exception of silicon carbide, ceramic refractory materials are poor conductors of heat. Their heat conductivity increases with temperature. Methods for determining heat conductivity are described. In grog blocks fired to 1000° and then heated to the same temperature, the heat conductivity lies between 0.0025 and 0.0038 g./cal. Opinions on the heat conductivity of silica blocks differ. The conductivity of magnesia blocks is twice that of grog blocks. Chromium blocks show almost the same value of about 0.0057 g./cal. for all temperatures. Carbon blocks seem to have a constant high heat conductivity at all temperatures. M.V.K.

Heat conduction problems. EZER GRIFFITHS. *Jour. Sci. Instruments*, **6**, 28–32

(1929); *Brit. Chem. Abs., B*, 381 (1929); for abstract see *Ceram. Abs.*, **9** [2], 109 (1930). (*J.I.M.*)

Mechanical solidity as criterion of the capability of resistance to temperature changes and chemical influences. V. Skola. *Zprávy*, **7** [1–2], 86–102 (1930); *Feuerfest*, **7** [2], 30 (1931).—Investigations are given on the change in the resistance to pressure of air-cooled blocks and blocks exposed to different chemical agents. M.V.K.

Studies of clay mixtures for glassmelting pots. I. Resistance to thermal shock. II. Shrinkage at high temperatures. J. H. Partridge and G. F. Adams. *Jour. Soc. Glass Tech.*, **15** [57], 59–83 (1931).—A test is described for determining the ability of fired specimens prepared from clay mixtures to withstand sudden changes in temperature such as are experienced when a pot is charged with batch. The test is not nearly as severe as the water-quenching method and it corresponds more closely to conditions met in practice. Tests have shown that the water-quenching method does not differentiate between those mixtures which do or do not crack in service, as it is too severe. Presence of too much fine grog in a mixture increases the tendency to crack, and the resistance to spalling of a given mixture can be improved by suitably grading the grog particles. Siliceous mixtures were found to have a decidedly lesser tendency to crack than aluminous ones in the same test. G.R.S.

Contribution to the study of the stability of aluminium, magnesium, and aluminium-magnesium silicate refractories at high temperatures and under corrosive influences. L. Servais. *Abhandl. Inst. Metallhüttenw. Elektromet. Königl. Tech. Hochschule* [Aachen], **2** [2], 53–69 (1916).—Refractory material having the composition, $SiO_2,6Al_2O_3$, withstands very high temperatures and does not give up silicon to metals melted in it under reducing conditions. Part or all of the alumina may be replaced by magnesia with satisfactory results, but not by lime. The composition, $2SiO_2,Al_2O_3,8MgO$, has the highest melting point in the ternary system and should prove a valuable refractory. (*J.I.M.*)

Refractories and refractory materials. A. M. Ravitch-Schterbo. *Messenger Metal Ind.* [Russia], No. 2, pp. 108–14 (1928).—The basic properties and qualities required of refractories, *e.g.*, Dinas brick, are critically reviewed from published data. (*J.I.M.*)

Study of refractory materials. I. Colin Presswood. *Blast Fur. Steel Plant*, **19** [6], 875–76 (1931); for abstract see *Ceram. Abs.*, **9** [8], 650 (1930). E.J.V.

Requirements and quality of refractory materials. A. Jaeschke. *Glashütte*, **60**, 73 (1930); see also *Ceram. Abs.*, **9** [8], 651 (1930). (*J.S.G.T.*)

Examination of refractory products. Marcel Lépingle. *Rev. mat. constr. trav. pub.*, No. 258, pp. 43–45*B* (1931).—L. determined the coefficient of thermal expansion of 21 refractories from temperatures of 0°C to temperatures from 150 to 400°C, below the fusion points of the products. Fire clay, magnesite, and lime show a marked increase in length at high temperatures. Zirconia, insulating, alumina, spinel, and silicon-carbide refractories show a sharp decrease in size at temperatures approaching the fusion temperatures. *Ibid.*, No. 259, pp. 67–70*B* (1931).—Below 750°C, the variation in compressive strength is less than experimental error. At 1000 to 1200°C, compressive strength increases due to the formation of a vitreous phase. Materials tested were high silica brick, refractories containing 20 to 22% Al_2O_3, some containing 35% Al_2O_3, and others containing 40 to 42% Al_2O_3. Increased strength follows increased Al_2O_3 content. For previous abstracts see *Ceram. Abs.*, **10** [6], 432 (1931). M.Y.H.

Rationalizing and standardizing ceramic industry. III. Eberhard Herfeldt. *Sprechsaal*, **64** [16], 296–97 (1931).—H. discusses the standardization of refractory building materials, treating (1) directions for testing artificially prepared and natural refractory materials, (2) their preparation and testing, (3) chemical analyses, (4) determination of

refractoriness, (5) testing of refractoriness under pressure, (6) ascertaining specific gravity, volume, and porosity, (7) determining resistance to pressure at room temperature, (8) measuring refractories, and (9) standards for Dutch tile. M.V.K.

Refractories poor in bonding materials. ANON. *Tonind.-Ztg.*, **55** [18], 260–61 (1931).—Newly patented methods for increasing the value of refractory ware by using the lowest possible ball clay content and as much grog (or other substance for diminishing plasticity) as possible are described. Some methods succeed in omitting the ball clay altogether, replacing it by finely ground thinning material. M.V.K.

Kaolin refractories. E. KÖHLER. *Refrac. Jour.*, **7** [5], 296 (1931); for abstract see *Ceram. Abs.*, **10** [3], 194 (1931). E.P.R.

Refractories and insulation. ANON. *Refrac. Jour.*, **7** [5], 282 (1931).—To secure greatest fuel economy, both refractories and insulation should be regarded as important equipment as are superheaters, economizers, and recording instruments. E.P.R.

Refractories in metallurgy. H. FORESTIER. *Refrac. Jour.*, **7** [5], 296 (1931); see also *Ceram. Abs.*, **10** [7], 565 (1931). E.P.R.

Refractories for steel pouring equipment. R. H. STONE. *Blast Fur. Steel Plant*, **19** [6], 865–71 (1931).—There are some 90 variations in design of stopper heads, sleeve brick, and nozzles for use in steel pouring. Third-grade fire clays, contrary to ordinary expectations, produce the best sleeves and nozzles. Natural graphite with suitable clay binders seems to be the best for stopper heads. The assembly of the head on the rod is discussed. Illustrated. E.J.V.

Refractory arches. R. HUSTIN. *Refrac. Jour.*, **7** [5], 296 (1931); see also *Ceram. Abs.*, **9** [9], 748 (1930). E.P.R.

Refractories for coke-oven walls. H. D. BENNIE. *Refrac. Jour.*, **7** [5], 296 (1931); for abstract see *Ceram. Abs.*, **10** [6], 436 (1931). E.P.R.

Furnace walls. GEORGE P. REINTJES. *Blast Fur. Steel Plant*, **19** [6], 859–61 (1931).—After a brief discussion of furnaces and combustion in general, R. points out that furnace wall failures can be attributed to (1) factors dependent upon the design, (2) factors dependent upon operation, and (3) factors dependent upon the construction of walls. The factors under these classifications are briefly enumerated and their effects on furnace walls are discussed. Illustrated. E.J.V.

Maintenance of refractory linings in foundry furnaces. F. NIEBLING. *Giesserei*, **18** [7], 144–46 (1931). (*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Improvement in kilns and durability of refractory materials. E. MAASE. *Feuerfest*, **7** [2], 20–25 (1931).—Viewpoints of M. on the standardizing of refractory materials used for kilns are presented. M.V.K.

Modern plant for refractory ware. J. ROBITSCHEK. *Zprávy*, **7** [1–2], 57–67 (1930); *Feuerfest*, **7** [2], 29 (1931).—Description of a modern German plant and the stages of preparation of refractory ware. M.V.K.

Manufacture and use of refractories in Germany. R. M. KING. *Blast Fur. Steel Plant*, **19** [6], 873–74 (1931).—Variations between American manufacture of refractories and German methods are pointed out with some detailed information regarding some of the properties of one German manufacturer's products. The variation in operating procedure in open-hearth practice is also pointed out. Illustrated. See also *Ceram. Abs.*, **10** [5], 356 (1931). E.J.V.

Slag erosion of refractories. STROMBERG. *Refrac. Jour.*, **7** [5], 296 (1931); for abstract see *Ceram. Abs.*, **10** [2], 123 (1931). E.P.R.

Destruction of refractories under the influence of molten peat ashes. D. S. BELIANKIN AND J. W. KLUTSCHAROFF. *Keram. Rund.*, **39**, 5–9 (1931); for abstract see *Ceram. Abs.*, **10** [2], 121 (1931). H.I.

Refractoriness of clay. P. A. ZEMIATCHENSKY AND F. A. ZENKOWITSCH. *Refrac. Jour.*, **7** [5], 296 (1931); for abstract see *Ceram. Abs.*, **10** [3], 195 (1931). E.P.R.

Refractory clays. V. ZEGSHDA. *Refrac. Jour.*, **7** [5], 296 (1931); for abstract see *Ceram. Abs.*, **10** [3], 198 (1931). E.P.R.

Effect of mode of manufacture on the properties of refractory clays. ANON. *Brit. Clayworker*, **40** [468], 19–20 (1931).—At the present time, fire brick are made by five different methods: (1) by hand, like building brick, (2) by a plastic process, with or without a previous drying of the raw materials, (3) the semidry process, in which the material is in the form of a powder which is compressed into shape in a press, (4) the casting process, and (5) in a combined slip and pressing process. These methods are described in detail. The porosity of goods made by the plastic and semidry processes is usually high; it is less with the stiff, plastic, and casting processes and least in the slip and pressing process. The temperature of firing and the type of grog used also affect the porosity. The mechanical strength varies greatly with the method of manufacture, but it also follows inversely the porosity. Slightly greater crushing strength is sometimes attained by the semidry process than by any plastic process, but this also depends on the size of the particles. The resistance to spalling of brick made by the last-mentioned process (combined slip and pressing) is extraordinarily high as is also their constancy of volume when heated. R.A.H.

Trend of research work in a modern refractories laboratory. WILLIAM F. BOERICKE. *Mining & Met.*, **12** [294], 274–77 (1931).—At the research laboratories of E. J. Lavino & Co., investigation of the following factors in refractories is conducted with regard to (1) their effects on the physical characteristics of the finished refractories, particularly the tendency to spall, resistance to deformation under load, and resistance to slag penetration, (2) changes in physical structure, (3) molecular arrangements, (4) coefficients of expansion, (5) particle size ratio, (6) particle shape, (7) distribution of bond, (8) correction of bond, (9) rate of change in bond structure with temperature, (10) volume-temperature curves, and (11) porosity. Descriptions of the expansion measuring and the volume-change apparatus are presented. The importance of the proper mesh ratio is pointed out. Illustrated. E.J.V.

Chemical analyses of refractory building materials. H. J. VAN ROYEN. *Tonind.-Ztg.*, **55** [34], 493–94 (1931).—Methods used and results obtained by König (see *Ceram. Abs.*, **9** [11], 941 (1930)) in his chemical analyses of silica and grog blocks and blocks with a high alumina content are discussed. See also *Ceram. Abs.*, **10** [7], 506 (1931). M.V.K.

Refractory tests: laboratory vs. mill conditions. W. C. KERNAHAN. *Blast Fur. Steel Plant*, **19** [6], 862–64 (1931).—The destructive factors under actual operating conditions differ greatly from those in the laboratory. Simulative service tests would aid the producer to present products backed by absolute knowledge of the expected service. Illustrated. E.J.V.

Testing refractories for cement kilns. J. SCHAEFER. *Zement*, **19**, 1112–13 (1930).—A furnace is described in which cement or powdered clinker is carried by the flame against the heated face of the refractory. (*C.A.*)

Some notes on the manufacture and performance of slip-cast tank blocks. P. HALLER. Presented at meeting of Soc. Glass Tech., March 18, 1931. Experience with blocks of various types exposed to varied conditions led to the conclusion that the erosive effect due to the rapid flow of the glass was the chief destructive agent to be overcome. The work described offered a direct comparison, based upon works trials, of slip-cast and plastic-shaped blocks. Parallel with development in casting, efforts were made to improve blocks from the same clay made by plastic shaping. Decided improvements resulted in general refractoriness and resistance to solvent attack, but practically no im-

provement in resistance to erosion. Hard-fired blocks with a porosity down to 19½% tended to crack under thermal stress, and hard firing alone did not smooth out previous defects. Methods of slip-casting blocks were described and particulars of procedures were given. Cast blocks had slightly less porosity than the corresponding handmade blocks, but the difference was small. Sillimanite blocks were fired to 20 to 21% porosity. The cast blocks possessed great mechanical strength, but the outstanding difference between comparable cast and handmade blocks lay in the texture, the greater regularity and homogeneity of texture of the cast block being patent on the most cursory examination. The handmade blocks were worn to destruction in normal time, although they had a porosity below 20%, while the cast blocks showed much less wear and were apparently good for many more weeks.

Standards for testing the probable behavior of tank blocks. W. MIEHR. *Jour. Soc. Glass Tech.*, **15** [57], 30–40 (1931).—Trustworthy conclusions can scarcely be drawn solely on the results of the Bowmaker procedure. For practical purposes the value of the Bowmaker factor is enhanced by the determination of the solubility factor of the mullite-free portion of the block composition. Pressed tank blocks with a low proportion of bond give comparatively unfavorable results unless they have been considerably vitrified. Highly aluminous tank blocks with a satisfactory mullite content can also prove failures in practice in spite of having a good Bowmaker factor if the block in itself is not homogeneous and thoroughly fired. Preference must be given to those blocks which possess, in addition to a suitable chemical composition, the lowest solubility when tested by Bowmaker's method, the lowest porosity, and the lowest percentage content of soluble mullite-free material. The laboratory results do not indicate any possibility of standardization in view of the diverse nature of the demands made upon tank blocks. Before this can take place, a definite relation must be established between the properties of the block, the laboratory results, and the actual durability in practice. G.R.S.

Improvements in manufacture of refractory blocks. ANON. *Tech. Bl. D. Bergv. Ztg.*, **20** [35], 730–32; [36], 750–51 (1930); *Feuerfest*, **7** [2], 29 (1931).—A description is given of (1) preparation of raw materials and grog, (2) rendering bodies homogeneous with additions of alkali and thereby economizing in ball clay, (3) preparation of silica raw materials and silica mortar of equal resistance as silica blocks, and (4) tunnel kilns for firing the blocks. M.V.K.

Influence of slag on refractory blocks. JOS. SCHAEFER AND FEL. BAUMHAUER. *Feuerfest*, **7** [3], 33–36 (1931).—A description of the method, data on the blocks and slag used, an estimation of test blocks according to their appearance, and investigation of the scorified layers with regard to thickness, density, and chemical composition are given. The chemical capability of resistance of refractory blocks can be investigated rapidly in the new testing kiln by blowing in slag. The estimation of the blocks according to their appearance and fractures is easily made and is confirmed by investigations based on the action of a steel-mill slag on silica and magnesite blocks. The quantity, thickness, density, and chemical composition of slag layers are given. An attempt to represent the degree of scorification numerically and in diagrams is made. M.V.K.

Manufacture of refractories at the Zlatoust Ceramic Works. W. N. SCHVETZOV. *Messenger Metal Ind.* [Russia], No. 9, pp. 58–71 (1927).—The clays of the Ural, southern, and central works of the U.S.S.R. are described, as well as the manufacture of fire brick, plugs, and steel-casting molds at the Zlatoust Ceramic Works. (*J.I.M.*)

Manufacture of Dinas brick. W. N. SCHVETZOV. *Messenger Metal Ind.* [Russia], No. 9–10, pp. 89–100; No. 11–12, pp. 77–84 (1926).—The quartzites used in the manufacture of Dinas brick consist of grains of quartz cemented together with dense amorphous silica, their structure depending on their origin. The quartzites from the Urals

are almost pure quartz. In those from South Russia, however, secondary silica predominates, while the grains of quartz are few. These southern quartzites are more rapidly converted into tridymite, the transition taking place at lower temperatures than with those from the Urals. It has been demonstrated at the Zlatoust Works that Dinas brick can be made from quartzites and quartz by appropriate methods. Impurities above 3% are harmful. A test of raw materials for the manufacture of Dinas brick is given. The melting point of nearly all the quartzites is the same and affords no criterion of the quality of the material. The specific gravity of the southern quartzites is less than for those from the Urals. The SiO_2 content of the Dinas brick is 94 to 96%. The strength of the brick, absence of growth due to cracking, minimum expansion through metamorphism, and ability to withstand changes of temperature are determined by the completeness of solution of the quartz grains in the glass of aluminium, iron, and calcium silicate during firing. The melting points of good and bad brick are identical, so that the refractoriness is measured, not by the melting point, but by its resistance at high temperatures and slagging properties. Micro-examinations and specific gravity determinations are the best means of determining the refractoriness. The method of manufacture of Dinas brick at the Zlatoust Ceramic Works is described. (*J.I.M.*)

Problem of the chemical transformation of Dinas brick. D. S. Beliankin. *Repts. Acad. Sci.* [U.S.S.R.], *A*, [17], 399–402 (1927).—Examination of a Dinas brick which had stood 600 fusion operations in a Martin furnace showed the presence of 3 zones. Chemical analysis of these zones established a difference of content of oxides of iron and manganese, the crystobalite zone, which was in contact with the atmosphere of the furnace, being less rich in them than the tridymite zone which is farther from the surface. The migration of the oxides, together with the formation of aggregates, resembles the phenomenon of diffusion in gels. (*J.I.M.*)

Titanium dioxide in Dinas brick. D. S. Beliankin. *Repts. Acad. Sci.* [U.S.S.R.], *A*, [22], 507–509 (1929).—Migration of TiO_2 in Dinas brick occurs at the expense of its own dioxide content. The concentration of TiO_2 is considerably greater in the tridymite zone. (*J.I.M.*)

High-alumina fire brick. J. F. Hyslop. *Roy. Tech. Coll. Met. Club Jour.* [Glasgow], No. 7, pp. 18–19 (1929–30).—For maximum refractoriness, resistance to stresses, and resistance to corrosion by slag it is desirable to have a high Al_2O_3 and thus a high mullite ($3Al_2O_3 \cdot 2SiO_2$) content. Spalling tendency is greatly increased by the presence of free SiO_2. While a high Al_2O_3 content is desirable, refractories with 60% or more Al_2O_3 tend to become more liable to spalling as the expansion coefficient increases with the Al_2O_3 content. Because of the cost it is economical only in extreme cases to employ materials with high Al_2O_3 derived from diaspore, bauxite, cyanite, or corundum. Properly made brick from clays approaching 45% Al_2O_3 show high resistance to temperature as well as to corrosion and spalling. (*C.A.*)

Properties of silica brick. Anon. *Corriere ceram.*, **12** [2], 61–67 (1931).—The important function of alkalis and alumina in facilitating the transformation, refractoriness, and dilatation of siliceous materials is discussed. Different results are obtained with the use of materials which seem similar from a chemical standpoint. M.V.K.

Black silica brick. Anon. *Brit. Clayworker*, **40** [468], 17 (1931).—It has been found that black silica brick from Siemens-Martin steel-making furnaces have a greater refractoriness and resistance to molten slags than new brick of the same original composition. A further examination showed that these black brick contain a large proportion of tridymite. It was found that the improvement in quality which has occurred while the brick were in use was due to (1) the absorption of iron silicates from the slag in the furnace, (2) the formation of an unusual amount of tridymite, and (3) the in-

solubility of the tridymite in the fused slag. After numerous trials it was found that the addition of as little as 1% of steel-furnace slag is sufficient to act as a catalyst and greatly increases the amount of tridymite formed. R.A.H.

Firing of Oldenburg klinker (brick). WERNER DOHM. *Ziegelwelt*, **62**, 2–4 (1931).—A slow, prolonged, even firing at about Seger cone 6*a* is essential in securing proper sintering and density. Slow cooling is equally necessary to prevent brittleness. (*C.A.*)

Crucibles. G. S. WATSON. *Refrac. Jour.*, **7** [5], 280 (1931).—The crucible of today can be relied upon to give 80 to 150 heats. While a portion of this remarkable increase in life can be attributed to foundry control, the bulk of it is due to unremitting research into the nature and properties of refractory materials, to the discovery of deposits of more refractory graphite and clay, and the incorporation of materials shrunk and stabilized in the electric furnace. Crucibles made from such ingredients possess greatly increased resistance to external wear by fuel slag and internal erosion by fluxes. E.P.R.

Modern crucible melting practice. G. S. WATSON. *Metal Ind.* [London], **38** [7], 189 (1931).—W. deals with crucibles and their behavior and compares them with other methods of melting. (*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Graphite crucible plant encounters unusual manufacturing problems. ANON. *Chem. Met. Eng.*, **38** [5], 282–84 (1931).—Foliated graphite, as a component of crucible mixtures, has a number of functions including the mechanical one of preventing any general fluxing of the crucible at high temperatures. As graphite is a good conductor of heat, it improves heat transfer, minimizes danger of breakage from heating and cooling strains, and reduces the coefficient of expansion within the crucible wall. A description, illustrated with photographs, is given of the various steps in the manufacture of graphite crucibles. G.R.S.

Uses for silicon carbide. CHARLES MCMULLEN. *Can. Chem. Met.*, **15** [5], 139–40 (1931).—Among the newer uses and adaptations of silicon carbide are (1) use in recuperators in regenerator systems, (2) for combustion chambers in "Carboradiant" furnaces, (3) in rotary metallurgical furnace combustion chambers, (4) for boiler furnace walls, (5) as units acting as ignition baffles in the intermittent type of oil burners, (6) for electrical-resistance heating elements, (7) as resistor elements in therapeutic lamps, (8) as detectors in radio, and (9) ceramically bonded silicon carbide as lightning arresters. Each is discussed. E.J.V.

Use of sillimanite as material for furnace covers. FRANZ SOMMER. *Blast Fur. Steel Plant*, **19** [6], 861 (1931); for abstract see *Ceram. Abs.*, **10** [3], 197 (1931). E.J.V.

Preparation of lime for silicate pastes. HANS KREMSKI. *Tonind.-Ztg.*, **55** [21], 307–308 (1931).—The proper method of preparing lime to be used in the manufacture of silicate blocks is explained. M.V.K.

Separation of cyanite and mica from quartz, feldspar, and other gangue minerals of a mica schist. F. F. HINTZE AND L. H. LANGE. Bur. Mines, *Rept. of Invest.*, No. 3085, 6 pp. (1931).—In the group of minerals used in making this study, the cyanite is associated with quartz, mica, and feldspar in the schist. The amount of quartz is variable, but it is always an abundant mineral. The cyanite is the heaviest of these minerals, having a specific gravity of 3.6. The results of the experiments made indicate that both cyanite and mica in a high state of purity may be recovered from the ore by means of crushing, screening, and tabling. For the highest purity of concentrates, additional screening and water classification might be employed. The tests also indicate that concentration should be carried on with as coarse a feed as possible. To obtain a coarse feed, the best procedure would probably be first to crush the ore with a jaw crusher, followed by screening in a closed circuit with rolls. Success in tabling depends upon

close sizing of the ore. No concentration studies were made on −100-mesh material due to the fact that microscopic examinations of this size indicate that it contains little cyanite and this is probably due to the hardness of the cyanite and its bladey structure. If it is desired to treat the fines, air separation might be a possible solution. R.A.H.

Trade in magnesite in 1930. JOSEPH ULMER. *Commerce Repts.*, No. 20, pp. 421–23 (1931).—The interest of the U.S. is largely in magnesite that may be used in two distinct industries, the production of refractory products, furnace and kiln linings, and the preparation of oxychloride cements. Austria and Czechoslovakia are the leading U. S. suppliers, with dead-burned Austrian magnesite predominant on the market for use in the metal industries. The Greek industry has been greatly affected by declining demand and increased competition. Russian magnesite resources are just being developed. In British India the production has been reduced. E.J.V.

Russian magnesite. ANON. *Brit. Clayworker*, **40** [468], 3 (1931).—The ever-increasing demand for magnesite as a basic refractory material for lining steel-melting and other furnaces, at prices lower than the Grecian material, has resulted in attention being drawn to the large quantity of this material in Russia. The chief source of Russian magnesite is worked by the Satk Works in the Zlatoust District on the Samara-Zlatoust Railway, where it occurs as a coarsely crystalline mass, nearly 100 ft. thick, comprising about 50 million tons. The calcined material shows magnesia 95.3%, iron oxide 1.9%, alumina 0.8%, lime 0.3%, loss on ignition 0.8%, and undetermined 0.9%. Since 1927 about 60,000 T. of this magnesite have been supplied. Another source of magnesite is at Chapilow in the Orenburg District. This material shows magnesia 85.3%, lime 1.4%, alumina 0.4%, iron oxide 1.6%, carbon dioxide 6.2%, water 4.1%, and undetermined 1.0%. About 6000 T. are supplied annually from this district.

R.A.H.

PATENTS

Furnace wall. OSCAR NYGAARD. U. S. 1,806,113, May 19, 1931. In combination with a permanent furnace wall, a refractory lining comprising successive horizontal, vertically spaced tiers of brick, each being one brick in height suspended from the permanent wall, rows of filler brick seated loosely in the spaces between the tiers, and means on the rear edge of each suspended brick for retaining the filler brick within the spaces.

Forming silicate refractory. JOHN D. MORGAN. U. S. 1,807,543, May 26, 1931. The method of forming refractory articles comprising heating zircon particles in the presence of less than $1^1/_2\%$ of insoluble carbonate material.

Supporting, constructing, and repairing furnace roofs. JOHN P. MCLIMANS. U. S. 1,809,209, June 9, 1931. An apparatus for use in repairing furnace roofs comprising, in combination, a brace adapted to span the roof, the brace being of a shape conforming substantially to the roof to be repaired, and a plurality of loop-shaped members having inwardly extending end portions arranged to engage within the side walls of brick forming the repair course, the members being provided with shoulder portions for engaging the brace whereby the brick are supported during the repair operation.

Refractory. JOHN D. MORGAN. U. S. 1,809,249, June 9, 1931. An article composed largely of zirconia bonded by the reaction products of zircon and phosphoric acid.

Manufacture of graphitic refractories. R. M. DOIDGE AND MORGAN CRUCIBLE CO., LTD. Brit. 348,149, May 20, 1931.

Preventing the deposition of carbon on ceramic ware during firing. I. G. FARBENINDUSTRIE AKT.-GES. Ger. 508,771, March 23, 1928; *Tonind.-Ztg.*, **55** [32], 470 (1931).—The deposition of carbon on ceramic materials which come in contact with gases during firing can be prevented by adding copper to the materials, *e.g.*, grog blocks are sprinkled with 10% solution of ammoniacal copper sulphate, or dipped in the solution for a few minutes, then left to dry. Blocks treated in this way are dried in air.

When used for lining in a brown coal generator, they showed no deposition of carbon after long usage. M.V.K.

Refractory brick. ROHN. Ger. 513,457; *Refrac. Jour.*, **7** [5], 296 (1931).—Synthetic corundum is mixed with 20% of alumina and fired at 1400 °C without a binding agent, preferably in an iron mold. E.P.R.

Apparatus for projecting refractory material onto furnace walls. BLAW-KNOX CO. Ger. 519,163, Feb. 28, 1929. (*C.A.*)

Process for manufacturing refractory and acid-proof ware. STETTINER CHAMOTTE FABRIK. Ger. 521,350, Dec. 24, 1924; *Tonind.-Ztg.*, **55** [34], 499 (1931).—Highly refractory and acid-proof objects can be prepared from zirconium, zircon dioxide, etc., for which colloidal thorium oxide is used as setting agent. Thorium oxide is used in the form of a mineral glue, obtained by treating thorium salts with acid, *e.g.*, by cauterizing thorium oxide with acid in boiling heat. M.V.K.

Terra Cotta

Structural ceramic bodies and glazes. W. HENZE. *Keram. Rund.*, **39**, 75–79 (1931).—Glaze compositions and precautions for treatment and firing of low-temperature structural ceramics including terra cotta, glazed tile, and glazed brick are given. H.I.

Moisture expansion of glazes and other ceramic finishes. H. G. SCHURECHT AND G. R. POLE. *Ceram. Ind.*, **16** [6], 548–50 (1931); see also *Ceram. Abs.*, **10** [6], 441 (1931). W.W.M.

Manufacture of porcelain face tile. R. JAMBERT. *Rev. mat. constr. trav. pub.*, No. 258, pp. 46–48*B* (1931).—To prevent deformation of tile, extreme precision is necessary in filling and emptying the molds. The tile are glazed without biscuiting by the Dorst machine, dried at 50 to 55 °C, retouched, put into saggers, and mechanically moved without jarring to kilns. Excellent results in colors have been obtained at 1400 °C which compare favorably with the chatoyant colors of faience; see also *Ceram. Abs.*, **10** [6], 442 (1931). M.Y.H.

Cause of light spots on terra cottas. ARNULF HOLL. *Keramos*, **10** [7], 183–84 (1931).—Light spots on red-fired terra cottas are usually caused by inhomogeneity of the raw material, or by damp gypsum molds. The latter must be always kept dry before use. It is recommended to fire terra cottas in an oxidized atmosphere and in saggers in order to avoid contact with gases and light ashes. M.V.K.

Defects and their prevention in the manufacture of fireclay Dutch stoves. ARTHUR HÜBLER. *Keram. Rund.*, **39**, 31–33 (1931).—Details of manufacture of these articles and means of prevention of specific defects are given. H.I.

Effect of lime in terra cotta. COSIMO ETTORE. *Ind. Silicati*, **9** [1], 15–16 (1931).—Excess lime lowers the resistance of terra cotta to atmospheric conditions. M.V.K.

Decorative treatment of tile. MICHAEL BIRKENBIHL. *Keram. Rund.*, **39**, 67–70 (1931).—A short history of the decorative treatment of ceramic tile in different countries is given. H.I.

Faience work. ANON. *Christian Sci. Mon.*, **23** [152], 14 (1931).—In the latter part of the 18th Century a faience factory on Herrebö farm, near Halden, Norway, produced the noted rococo Herrebö faience in cobalt blue and brown on white glazing. The ceramic and faience production of Egersund faience factory and Graveren brick works at Sandnes is of highly modern design and fine coloring and equals the best of its kind. E.J.V.

Adaptability of clay products. ANON. *Brick Clay Rec.*, **78** [11], 596–97 (1931).—Clay products are adaptable to every architectural idea. This is proved by photographs

of various types of buildings. Brief descriptions of the particular products used in each case are given. E.J.V.

BOOK

Modern European Buildings. F. R. YERBURY. Payson and Clarke, Ltd., New York. Price $10. 2 pp. of text, 145 pp. of illustrations. *(D.I.)*

PATENTS

Fixture tile. GERALD H. MCFARLIN. U. S. 1,807,630, June 2, 1931. An article of manufacture comprising a fixture tile having a recessed back surface, a nonfrangible apertured plate mounted in the recess, and means comprising cement partially covering the plate and extending through the apertures therein for securing the plate to the tile, the plate having projections extending beyond the edges of the tile and adapted to receive mechanical securing means.

Building brick, roofing tile, etc. H. P. YOUNGMAN. Brit. 347,109, May 6, 1931.

White Wares

Engobe for tile and building ceramics. ANON. *Master Builder*, No. 826, p. 48 (1931); *Tonind.-Ztg.*, **55** [25], 378 (1931).—The slip consists of plastic clays with an addition of 5% iron oxide. For clays which do not retain the engobe, an addition of the same clay, fired and ground, suffices. An addition of a flux material as feldspar complicates the preparation of the engobe and must be avoided. Iron oxide (red), manganese dioxide (brown), and copper oxide (green) are mostly used as coloring admixtures in a quantity of about 3%. Working methods: (1) The casting method is good but requires skill; recently it has been done mechanically. (2) The immersing method is rapid but wasteful of materials. (3) The spraying method is somewhat longer but is economical in use of engobe; it requires less time for removing the excess slip. The cheapest way is to apply an engobe on fresh ware; the safest, is to apply it to fired ware as the engobe adheres best to porous bodies. Dried and half-dried ware can be coated with an engobe only when they are made of suitable material, which is seldom. The best consistency of slip is that of milk. Clay used for engobes must be weathered for several days in order to saturate its particles with water. The finishing burn temperature of an engobe must correspond to the finishing burn temperature of the body. M.V.K.

Influence of the kind of shaping on the behavior of porcelain bodies during drying and firing. R. RIEKE AND H. KEEDING. *Keramik*, Vol, 10, pp. 193–200 (1930); *Sprechsaal*, **64** [18], 336 (1931).—Numerical bases for the dependence of shrinkage and contraction during drying and firing on the kind of shaping were determined. Two porcelain masses with 50% clay substance, 25% quartz, and 25% feldspar were used. Zettlitz kaolin was used in one case and Waldenstein blue clay in the other. Bodies showed that the drying shrinkage and shrinkage on firing to redness increases with an increase of the water content. At higher temperatures the reverse is true. Masses containing clay shrink somewhat more during drying and heating to redness, and less at higher temperatures. They reach their highest shrinkage at Seger cone 6*a* and have a higher total shrinkage. Bodies with a higher water content showed clearly the advantages of the soda casting over the process where water alone was used for liquefying the slips. Masses prepared with soda are denser, have a reduced pore space, and accelerated sintering. The most suitable soda concentration must always be tested. When investigating pressed bodies (3% water), a small increase in size during drying was found, and the greater the pressure used during molding, the smaller the firing and

total shrinkages. The total shrinkage is much lower in pressed than in cast and molded bodies. M.V.K.

Measuring heat expansion on fired whiteware masses for preventing cracks. H. MÖHL. *Sprechsaal*, **64** [13], 241–43; [14], 259–61 (1931).—A commercial apparatus is described with which simple and quick calculations of heat expansion of fired ceramic materials can be made. The significance of measuring the expansion in order to prevent the appearance of fine cracks is discussed and directions are given for the preparation of bodies with appropriate expansion coefficients for different glazes (to make them adhere without fissures). Directions for the adaptation of porcelain glazes to certain bodies were given by Rieke and Kunstmann (see *Ceram. Abs.*, **8** [10], 753 (1929)). M.V.K.

Causes of cracks in the manufacture of tile, etc., and ways of correcting them. ANON. Deutsche Ziegel Zeitung. *Rev. mat. constr. trav. pub.*, No. 259, pp. 65–66*B* (1931). M.Y.H.

Silicon carbide as impurity in porcelain. M. MIELDS. *Sprechsaal*, **64** [15], 277–79 (1931).—M. discusses several cases of the appearance of silicon carbide in porcelain bodies and its action on porcelain and glazes during firing. Researches to determine its origin were not successful. Illustrated. M.V.K.

Cause of fading of decorations on porcelain ware during cleaning. H. KOHL. *Sprechsaal*, **64** [16], 295–96 (1931).—K. discusses the fading of colors on porcelain ware during washing in large plants and concludes that the colors used in the porcelain industry are not sufficiently stable. M.V.K.

Durability of bone china. A. S. W. ODELBERG. *Pottery Gaz.*, **56** [648], 842–43 (1931).—After a general description of the type body and production methods used in making bone china in Sweden, methods for testing the density of the body and glaze fit are described. An impact test in which a 30 g. steel ball is dropped upon the middle of a plate from varying heights is described as are edge chipping tests. Comparisons of bone china with earthenware and porcelain show that the bone china is most resistant to chipping and also superior for decorations. Results of a practical test where the ware was in restaurant service are described. O. summarizes the reasons why bone china is the best type of pottery that can be used for hotel ware. E.J.V.

Works laboratory in the electrical-porcelain industry. ANON. *Keram. Rund.*, **39**, 22–23 (1931).—In electrical-porcelain manufacturing where the cost of the product is great, careful physical and chemical control of every stage of the process is essential. The necessity of rather complete chemical analysis of every raw material, including the determination of Na_2O and K_2O separately in the feldspars, is stressed. H.I.

Technical advances in fine ceramics in 1930. W. STEGER. *Keram. Rund.*, **39**, 47–53 (1931); for 1928 review see *Ceram. Abs.*, **9** [1], 50 (1930) and for 1929 review see *Ceram. Abs.*, **9** [11], 953 (1930). H.I.

Rationalizing and standardizing the ceramic industry. II. EBERHARD HERFELD. *Sprechsaal*, **64** [14], 262–63 (1931); for Part I see *Ceram. Abs.*, **10** [5], 366 (1931). M.V.K.

Porcelain for the modern dwelling. JOH. GRELL. *Keram. Rund.*, **39**, 2–4 (1931). H.I.

Cutting costs. RICHARD L. CAWOOD. *Ceram. Ind.*, **16** [6], 524 (1931).—The new plant and equipment of the Hall China Co., East Liverpool, Ohio, are described and illustrated. W.W.M.

Experiment and tradition in the potteries. JOSEPH BURTON. *Pottery Gaz.*, **56** [648], 837–39 (1931).—To appreciate what English pottery has done, it is necessary to know something of the development of the industry during the past two hundred years, rising from a product of a peasant handcraft to well-designed pottery. The in-

fluence of tea drinking on design and type of product, potters' achievements in the 18th Century, oriental design, "accepted" decoration, nature and design, tradition, relation of design to shapes, and copying are discussed. E.J.V.

Potthoff and Flume plant. ANON. *Emaillewaren-Ind.*, **8** [8], 59–61 (1931).—A description is given of the Potthoff and Flume plant in Lünen, Germany, manufacturing glazed Dutch tile stoves. M.V.K.

Famous Chinese potteries near extinction. ANON. *Christian Sci. Mon.*, **23** [169], 1 (1931).—More than 90% of the famous Kiangsi chinaware factories, centering around Chingteh, have been closed during the last 10 years due to civil war, etc. It was due to the popularity of Chinese porcelains that the name of "china" was given to them. Chingteh dates back some 900 years, and was China's center of the porcelain industry. E.J.V.

Paraguay and Uruguay porcelain and earthenware in the world market. H. E. HULDSCHINSKY. *Keram. Rund.*, **39**, 39–41; 53–56 (1931). H.I.

BOOK

Modern Tilemaking. A. B. SEARLE. Published at 43 Essex Street, Strand, W. C., England. 430 pp. Reviewed in *Brit. Clayworker*, **40** [468], 36–37 (1931).—"Modern Tilemaking" is the most comprehensive exposition on tilemaking in the United Kingdom yet produced. It is a volume of information as to what others are doing in widely separated spheres, but all in the same industry and producing similar goods. A comparison of British methods of manufacture with continental would have been helpful because all tilemakers are confronted with foreign competition. S. shows that some very crude methods of tilemaking still exist in England. A comparison of costs involved in the different methods of manufacture would be interesting. He shows a wide knowledge of geological formations occurring in the United Kingdom, the clays suitable for tilemaking which are found in the various formations, and of the mechanical appliances essential to the industry. This book will take its place as a classic handbook of the tilemaking industry. It is valuable for reference on every point which may present difficulty. R.A.H.

PATENTS

Heater porcelain. ROBERT J. PARSONS. U. S. 1,806,115, May 19, 1931. The combination with a holding block for resistance wire provided with two parallel surface grooves connected across at one end of a coil in the grooves, the coil being continued through the cross-connecting groove and provided with end terminals at the opposite end of the block, the grooves having laterally offset bends at intervals so as to provide pinching spots shaped to grip and prevent vibration of the coil.

Insulator cutter and method of treating insulators. MINOR F. H. GOUVERNEUR, U. S. 1,808,105, June 2, 1931. A device of the character described comprising a supporting member adapted to be mounted upon the top of an insulator, bracket members on the support, and a cutter pivotally mounted on the bracket members and having a substantially U-shaped blade adapted to cut through the material of the insulator along an accurate path for scooping out the material at one side at a relatively small area.

Sanitary fixture. RAYMOND E. CRANE. U. S. 1,808,294, June 2, 1931. A sanitary fixture comprising a flush tank for closets, etc., having combined therewith and supported thereby a lavatory basin, a discharge outlet for the tank and a separate and independent discharge outlet for the basin.

Water closets and pedestal pans. W. F. G. JONES. Brit. 347,313, May 6, 1931.

Manufacture of ceramic articles such as insulators. BULLERS, LTD., AND J. E. HARRIS. Brit. 347,612, May 13, 1931.

Glazed wall slabs or tile. P. HOFER AND A. SCHMID. Brit. 348,063, May 20, 1931.

Handles for hollow ware and other articles. A. NOIRIT. Brit. 348,462, May 20, 1931.

Equipment and Apparatus

Science and practice of drying. ANON. *Brit. Clayworker*, **40** [468], 10–12; [469], 52–55 (1931).—The most scientific fact in connection with drying is that water requires for its evaporation, roughly 1000 times as much heat as it requires to heat it up 1° of temperature. Another fact is that water dispersed in a wet clay, when it is drying, obtains some of these thousand units from the wet clay itself and does not obtain them all from the air surrounding it even if it is warmed to a moderate degree. The humidity principle of drying clay products involves the heating of the goods in a closed chamber which is not ventilated until the ware has become considerably warmed. The amount of heat which a fluid such as air will convey depends on its specific heat. Artificial drying by controlled volumes of air at controlled temperatures must be considered in connection with the amount of water vapor which can be absorbed and carried away by the air at its final temperature. A table is given which shows how rapidly the weight of air required to carry 1 lb. of water vapor decreases as the temperature of it rises. The brick drying tunnel is the result of research to establish the best way in which to supply heat and to remove moisture in a manner so graduated as to avoid damage to the product and to dry it in the shortest possible time. Tunnel driers may be supplied with air under two widely differing conditions. Either the air moves in a direction (1) opposite to that of the movement of the ware or (2) in the same direction. These two methods of drying are discussed in detail with computations showing that there is an economy of heat in the direct system of ventilation of about 22%. The humidity drier is also discussed and computations showing the efficiency of it are given. R.A.H.

Reducing sensitiveness in drying. ANON. *Brit. Clayworker*, **40** [468], 12–13 (1931).—There is not and cannot be any type of drier which can be used with equal satisfaction for every kind of clay or all sorts of clayware, because of the different degrees of sensitiveness to drying shown by various articles. The causes of this sensitiveness are numerous, the most important being the size, shape, and packing of the particles of clay present. Each type of ware must be studied separately for its drying properties but the following general arrangement is easily adapted to local needs: (1) The goods must be warmed throughout to a temperature of 50 to 60 °C without any surface drying, the atmosphere at this stage being saturated with moisture. (2) The temperature must be kept constant, but the amount of moisture in the air in the drier reduced. (3) The temperature is increased and maintained until the goods are completely dry. The precise temperature in each stage, the rate at which the moist air is replaced, and the temperature increased depend on local conditions. R.A.H.

Moist air drying. F. LIPINSKI. *Tonind.-Ztg.*, **55** [19], 272–74 (1931).—This process is based on the fact that the diffusibility of clay increases with the rise in the temperature of the clay. It is characterized by (1) the separation of the heating from the actual drying of the ware, and (2) complete independence from atmospheric conditions. In every phase of the process the degree of saturation of the air used both for heating and drying is carefully regulated. Ware difficult to dry is thoroughly dried in a short time by this process, which is described. M.V.K.

Drying characteristics of clay; their effect on drier design. WALTER W. SIBSON. *Brick Clay Rec.*, **78** [9], 495–96 (1931).—In drying clay products, the most important problem is to properly coördinate the rate of moisture removal with certain other phenomena which take place during the drying. A study of the particular product to be dried is necessary as drying characteristics vary both with the compositions of the clay and with different shapes made from the same clay body. The drying cycle is divided

into two parts: the period during shrinkage, made up of three stages, and the post-shrinkage period of one stage. These stages are discussed. Points of importance in the design and construction of modern drying equipment are positive distribution of air, uniform drying, and efficiency. Illustrated. E.J.V.

Accelerating drying of ceramic products. P. P. BUDNIKOFF, G. V. KUKOLEV, AND E. L. MANDELGRÜN. *Tonind.-Ztg.*, **55** [28], 409–11 (1931).—Drying ceramic objects can be accelerated by (1) introduction of thinning agents; (2) thermal working of the clay (heating up to 400° partly removes the plasticity, the mass becomes granular, loses its colloidal state, and dries more rapidly), and (3) introduction of substances which coagulate the clay particles and increase their bulk (this facilitates the movement of liquids in the capillary channels to the surface of the objects). Investigations were made to determine the influence of different electrolytes on the rate of drying of different objects made of plastic clay (composition given). Aluminium and iron salts combined with hydrochloric acid and sulphuric acid, common salt, and phosphoric acid were used as electrolytes. The tests showed that the introduction of definite quantities of $Al_2(SO_4)_3$ (0.25%) and $FeSO_4$ (0.5%) considerably accelerate the rate of drying of samples. The firing process is facilitated also. The introduction of $FeSO_4$ to accelerate drying is recommended, but an optimum quantity of coagulant must be selected depending on the local circumstances (nature of the raw clay). M.V.K

Progress made in drying of ceramic materials and objects. VDI. BELANI. *Rev. mat. constr. trav. pub.*, No. 258, pp. 53–57*B* (1931).—B. recommends the use of the cell drier for zirconia, and compartment and tunnel driers using the Haas system for refractories, faience, stoneware, and porcelain objects made in molds. M.Y.H.

Drum driers. ANON. *Tonind.-Ztg.*, **55** [31], 455 (1931).—A new "Buckauer drum drier" is described. These driers are used for drying ceramic raw materials and work on the principles of continuous-current or counter-current driers. M.V.K.

Optical pyrometer for furnace temperatures. ANON. *Jour. Sci. Instruments*, **7**, 171 (1930).—A simple pyrometer whose range is 900 to 2000°C, made by Messrs. Viozone, Ltd., and suitable for taking the temperature of pouring metal is described. The instrument consists of a strip of glass shaded from reddish to dense opaque, and mounted on a scale. The metal is viewed through an eyehole which is moved until the glow is no longer visible, when the scale reading gives the temperature. (*J.I.M.*)

Recent improvements of the pyrometer in industry. GÉRARD ANSIEAU. *Aciers Spéciaux*, **3**, 541–53 (1928).—A detailed description of various types of pyrometer and electric temperature regulators is given. (*J.I.M.*)

Destruction of pyrometers. ANON. *Sprechsaal*, **64** [9], 168 (1931).—Instances of pyrometers having been destroyed by hot gases and slag are cited and means of avoiding this are given. M.V.K.

Improved all-electric operated pyrometer. WILSON-MAEULEN CO. *Clay-Worker*, **95** [5], 350 (1931); *Glass Ind.*, **12** [6], 138 (1931).—Details of the structural and operating characteristics of a new series of improved Tapalog recording pyrometers are described. Illustrated. E.J.V.

Radiation pyrometry. E. L. FIDGE. *Chem. Eng. Mining Rev.*, **23**, 189–94 (1931).—The application and use of radiation pyrometers in industry and laboratory research are discussed. (*C.A.*)

New Brown potentiometer pyrometer. THOMAS R. HARRISON. *Ceram. Ind.*, **16** [6], 566 (1931).—H. describes a new instrument of the Brown Instrument Co., which will indicate, record, and automatically control temperature. The instrument incorporates some 53 features new to potentiometer pyrometers, among which is a correction for expansion and contraction of the chart paper due to humidity changes. Automatic temperature control is obtained through mercury switches. W.W.M.

Furnace for the rapid calibration of thermocouples. FRANK ADCOCK. *Jour. Sci. Instruments*, **7**, 196–97 (1930).—A simple silica furnace for the rapid calibration of platinum-platinum rhodium thermocouples by the "gold-wire" method, in which from one to three turns of pure gold wire are pressed tightly around the thermocouple junction, is described. Using 7 amperes at 70 volts the furnace reaches the gold point in from 2 to 3 minutes. The disadvantage of the method is that a short piece of the thermocouple wire must be removed, and the junction remade after each calibration. (*J.I.M.*)

New kilns at the Leipzig Fair, 1931. ANON. *Emaillewaren-Ind.*, **8** [9], 68–69; [16], 124–25; [17], 131–32 (1931).—Latest models of laboratory kilns made from corundum, silicon carbide, and quartz, and fired with gas, attaining temperatures of 1500 to 1600° in a very short time; special high-temperature kilns fired with gas on the surface firing principle, attaining temperatures of 1800 to 2000°C, and made of highly refractory oxides of alumina, magnesium, zirconium, beryllium, and thorium, are described. M.V.K.

International comparison of viscometers. S. ERK. *Jour. Rheol.*, **2** [2], 163–68 (1931).—Several conversion methods taken from the literature for the comparison of conventional viscosity units (Engler degree, Redwood, and Saybolt seconds) with the absolute units are grouped together and the deviations of the single formulas and tables are discussed. The proposal is made with the coöperation of the three national institutes (National Physical Laboratory, Physikalisch-Technische Reichsanstalt, and the Bureau of Standards) within the interested countries, England, Germany, and the U.S. to agree to a conversion table or formula and to combine such national agreement in an international agreement at the International Congress for Testing Materials at Zürich in 1931. G.R.S.

Photoelectric recording instruments. ANON. *Ceram. Ind.*, **16** [6], 564–66 (1931).—By using photoelectric cells and pliotron tubes the General Electric Co. has developed recording instruments adaptable where only a limited amount of energy is available. The operation of such an instrument is described. W.W.M.

Tests on the workability of clays and ceramic bodies with the aid of a ball-plastometer. WILLI M. COHN. *Tonind.-Ztg.*, **55** [17], 238–40 (1931).—Tests and their results are described. M.V.K.

A simple dilatometer. R. C. GALE. *Jour. Sci. Instruments*, **7**, 131 (1930).—A simple dilatometer suitable for determining the coefficients of expansion of metals, transformation points, etc., is described and illustrated. The apparatus is designed for specimens 2 in. in length, enclosed in an electric furnace, and the expansion is read on a dial gage graduated in $^1/_{100}$ mm. (*J.I.M.*)

Temperature-measuring equipment. ALLAN FERGUSON. *Jour. Sci. Instruments*, **7**, 63–64 (1930).—A brief survey is given of some of the temperature-measuring instruments shown at the Twentieth Annual Exhibition of the Physical and Optical Societies. These include a direct insertion thermocouple made by the Foster Instrument Co. In this, the two bare wires are inserted in the molten metal which makes contact between the ends, so that the lag is inappreciable, but the metals burn away, and are renewed by feeding the wires forward from spare spirals. (*J.I.M.*)

Simple pipette for microfiltration. R. EDGEWORTH-JOHNSTONE. *Jour. Soc. Chem. Ind.*, **50** [21], 182 (1931).—A diagram and description are given of a new microfiltration pipette. G.R.S.

Progress in the application of electrical precipitation to the cement industry. H. A. SCHAFFER. *Rock Prod.*, **34** [11], 49–53 (1931).—S. discusses the use and distribution of dust precipitators in the various industries and countries. He describes the apparatus and tells of its improvements and changes in construction. Advantages of the "rod curtain" type precipitator are given. Factors influencing the percentage of dust

in a gas are presented. Kiln dust losses average 6 to 8% of the feed for the entire cement industry. With electrical dust precipitators 90% or more of this loss could be recovered. The treatment of mixed kiln and drier gases is discussed. Illustrated. W.W.M.

Lurgi's electric precipitator for cement plants. ANON. *Rock Prod.*, **34** [11], 94 (1931).—This equipment is applicable for purification of waste gases from wet- and dry-process rotary kilns, shaft kiln drying drums for raw materials with direct firing or waste-gas firing, etc. In wet- and dry-process cement plants electric purification of waste gases saves large amounts of material and kiln capacities can be increased without causing dust nuisance in the neighborhood. A drawing shows the arrangement of electrical precipitation in a modern cement plant. W.W.M.

Determining the thickness of chromium plate. ANON. *Metal Ind.* [London], **36**, 604 (1930).—A method of estimating the thickness of chromium deposits, developed by the General Testing Laboratories, Inc., Detroit, Mich., is described. The test is entirely visual and gives the thickness in 5 millionths up to 30 millionths of an inch. (*J.I.M.*)

Testing chromium plate for resistance to abrasion. H. C. WOLFE. *Metals & Alloys*, **2**, 60–61 (1931).—A plated specimen rests horizontally, under the influence of a determined load, on a Norton 120J alundum wheel (diameter 2 in., face $^1/_4$ in.). The wheel is rotated at a linear speed of 10 ft./min. and is cleaned continuously. A dial gage measures the depth of the cut directly to 0.0001 in. Increased accuracy was obtained by the use of a copper wheel rotating in a mixture of levigated alumina, but the operation is longer and the abrasive mixture soon becomes contaminated with particles of chromium. The results of comparisons of the quality of different chromium plates were satisfactory, but were not so when compared with the abrasive resistance of other metals. (*B.C.A.*)

Design, construction, and operation of a constant-humidity room. P. H. PRIOR. *Proc. Tech. Sect. Paper Makers' Assn. Gt. Brit. & Ireland*, **9**, 152–74 (1929).—The points to be considered in the design of such a room are discussed and details are given for the construction of a room 12 ft. x 15 ft. x 7 ft. 10 in. Provision is made for complete change of air 4 times per hr. or for recirculation of the air over the controls when the room is only used for conditioning samples. Humidity and temperature control are effected by diverting part of the air over the correcting devices (humidifier, refrigerator, and heater) by means of electric fans controlled by a hair hygrometer and a bimetal strip. The controls normally operate at about 5-min. intervals and to within 1% relative humidity and 1°F. (*C.A.*)

Determining the thermal conductivity of pulverized substances at high temperatures. M. PIRANI AND VON WANGENHEIM. *Stahl Eisen*, **50**, 171–73 (1930); *Tonind.-Ztg.*, **55** [23], 350 (1931).—The apparatus consists of two concentric cylinders between which the test material is inserted. The inner cylinder is heated with electricity and the heat flows out through the test material into the other cylinder which in turn radiates it. The inner and outer temperatures and the absorbing capacity are measured at the beginning of the resistance, and the thermal conductivity calculated. Quartz fragments, sand, diatomaceous earth, and silicon carbide were investigated. See also *Ceram. Abs.*, **10** [6], 431 (1931). M.V.K.

Heat conductivity measurements made by a modification of Kohlrausch's method at high temperatures. R. HOLM. *Z. tech. Physik*, **10**, 621–23 (1929).—The thermal conductivity of a rod may be calculated from the rise in temperature of the rod when a current is passed through it while heat is prevented from radiating from it, so that heat is lost only by conduction at the ends. The method and an apparatus for making a determination are described. (*J.I.M.*)

Electrical heating of press pistons. ANON. *Brit. Clayworker*, **40** [468], 20–21 (1931).—The details are given showing the application of Chromalox electrical heating elements to the top piston of a semidry brick press. The Chromalox elements are made by enclosing an $^{80}/_{20}$ nickel chrome resistor, in helix form, in a heat-resisting chromium steel sheath. The helix is so completely embedded by hydraulic pressure in a refractory material that it does not become displaced, and is so wound as to ensure it running at an even temperature throughout its length. R.A.H.

New cell for electrodialysis. H. N. HOLMES AND A. L. ELDER. *Jour. Phys. Chem.*, **35** [5], 1351–54 (1931).—A new, inexpensive, and efficient cell for electrodialysis is described. It was proved that, using $N/100$ NaCl, no test for chloride ions could be obtained after 10 hours of dialysis at 155 volts and 65 to 70°C. G.R.S.

Pressure exerted by granular material: an application of the principles of dilatancy. C. F. JENKIN. *Proc. Roy. Soc.* [London], **131***A* [816], 53–89 (1931).—A new apparatus was devised capable of giving reliable data on granular pressures. The results showed that (1) the direction of the force on a wall is inclined to the normal at the friction angle; (2) the position of the center of pressure is indeterminate and may be much higher than one-third of the height of the wall; (3) the distribution of pressure is consequently different from the commonly accepted triangular distribution; and (4) the pattern of the packing is of fundamental importance; this includes both closeness and geometrical arrangement. Two patterns have already been recognized in sand, (*a*) ordinary loosest and (*b*) arched loosest packing. Close packing has not yet been investigated. None of the experiments contradict the results deduced from the principles of dilatancy in any way. All the investigations relate to dry granular material, clay being a different matter. G.R.S.

Compressed air. FRED D. HARTFORD. *Factory & Ind. Management*, **81** [6], 1002 (1931).—The qualities, uses, manufacture, and cost of compressed air are discussed. E.C.C.

Making sewer pipe. ANON. *Brit. Clayworker*, **40** [469], 56–60 (1931).—A machine for making socketed drain pipes entirely free from lamination and blistering is described. The general principle of the invention, which is the work of E. G. Clifford-Jones, Johannesburg, Transvaal, is the extrusion of the clay under pressure by confining it during its issue from the die within an external sleeve or mold and around a cylindrical polished core. After the full length of the pipe has been formed in the annular space between sleeve and core, the core is withdrawn, and the mold with the pipe inside it is removed to the drying room. Within a few hours the pipe has contracted sufficiently to leave the mold which is then returned to the machine for a repetition of the operation. An ingenious feature of the invention is the arrangement by which the whole length of the pipe, after formation of the socket in the usual way, is extruded into the mold under the same pressure throughout, thus ensuring uniformity in the texture and consistency of the clay substance. R.A.H.

Sieve tests of iron-containing chinaware. O. KRAUSE. *Sprechsaal*, **64** [20], 374–75 (1931).—According to experimental results, iron cannot be completely separated from chinaware bodies by using magnets alone, especially if the iron is contained as rust. Satisfactory results, however, are obtained by using a sieve with 3600 meshes/sq. cm. W.M.C.

Vibration sieves. ANON. *Tonind.-Ztg.*, **55** [27], 399–400 (1931).—A new vibration sieve, "Record," with circular vibration is described. M.V.K.

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 258, pp. 48–51*B* (1931).—Disadvantages of vertical pug mills are (1) difficulty in working fat clays and (2) difficulties in cleaning. Three fatal accidents and installation of safety measures are described. *Ibid.*, No. 259, pp. 73–75*B* (1931).—The following

safety measures are recommended for prevention of accidents: (1) enclosure of gears, (2) installation of door for cleaning, and (3) use of warning signs. Six different pug mills with double control are described. See also *Ceram. Abs.*, **10** [7], 514 (1931). M.Y.H.

New aging mixer. ANON. *Tonind.-Ztg.*, **55** [25], 372–73 (1931).—A new aging mixer for working raw materials difficult to disintegrate is described. It can be installed between the edge mill and the wire cut press. M.V.K.

New mixer. ANON. *Sprechsaal*, **64** [8], 187 (1931).—A new counter-current rapid mixer, "Eirich," is described. These mixers are especially adapted for preparing bodies for high-quality products. M.V.K.

Pugging and compressing. E.-G. GUERRÉE. *Rev. mat. constr. trav. pub.*, No. 258, pp. 41–43*B* (1931).—Horizontal and vertical pug mills are compared. The superiority of the former is demonstrated on the basis of ceramic functioning in the manufacture of brick and tile and refractories. *Ibid.*, No. 259, pp. 70–72*B* (1931).—A description is given of a machine which performs the two processes of pugging and compressing with a resulting economy of power and labor. M.Y.H.

Pugging machines and press for wire cutting. C. DORNEDDON. *Sprechsaal*, **64** [17], 313–16; [18], 332–34 (1931).—D. describes the work of different pugging machines and presses for wire cutting and points out their defects. Means are given to improve their work. M.V.K.

Dustless portable sanding machine. ANON. *Elec. World*, **97** [23], 1084 (1931).—A new model sanding machine, known as type B-10 dustless take-about sander, has been announced by the Porter-Cable-Hutchinson Corp., Syracuse, N. Y. This model has eliminated the difficulty of controlling the dust by a special dust-removal system built into the machine. A double blade fan traveling at 10,000 r.p.m. creates a powerful vacuum which draws the dust through ports directly in back of the rear pulley and deposits it in a bag. Dust is removed from this bag through the zipper opening. G.R.S.

Pumping unit includes gears, motor, and control. ANON. *Elec. World*, **97** [21], 976 (1931).—The unit pumping equipment manufactured by Nuttall Works of the Westinghouse Electric & Manufacturing Co. is claimed to be the first and only electric pumping power having the entire drive, reduction gears, motor, and control combined into a single compact unit of weather-proof construction; eliminating the necessity for any shelter house. This unit drive assembly requires only one foundation and once in place there remains only the connection of three wires between the control and the power supply. All other wiring is done during manufacture. The high-torque, squirrel-cage type a.c. motor is reduced to its bare elements of rotor and primary core with coils. It has no separate frame, no feet, shaft, brackets, or bearings. G.R.S.

New glass batch collecting car. ANON. *Ceram. Ind.*, **16** [6], 566 (1931); for abstract see *Ceram. Abs.*, **10** [7], 512 (1931). W.W.M.

Manufacture of tile on a traveling belt. AD. LEISTER. *Tonind.-Ztg.*, **55** [29], 419–20 (1931).—L. discusses the possibilities of manufacturing tile on a traveling belt. Illustrated. M.V.K.

Rule for crossed belt drives. W. F. SCHAPHORST. *Brick Clay Rec.*, **78** [11], 610 (1931).—A new rule applying to high-grade, 2-ply leather belting for crossed drives is explained and illustrated. See also *Ceram. Abs.*, **9** [4], 295 (1930). E.J.V.

Handling. E.-G. GUERRÉE. *Rev. mat. constr. trav. pub.*, No. 259, pp. 61–65*B* (1931).—Two systems are recommended for the purpose of diminishing hand labor by mechanical handling in ceramic factories: (1) by use of continuous conveyers and (2) by use of trucks. The methods may be employed jointly or separately according to the need of the factory. M.Y.H.

Truck motor used in crane operation. ANON. *Elec. World*, **97** [21], 976 (1931).—Power from the truck motor is used in all operations including load line and raising and lowering of the boom. Less than 40 in. of space is needed back of the cab. The crane has a rated capacity of 5 tons at a 6-ft. radius from the side of the truck and with the boom 12 ft. long can also handle loads up to $2^1/_2$ tons at a 12-ft. radius or horizontal reach. The height of the crane from the top of the chassis frame is 7 ft. 9 in. G.R.S.

Drip-proof motor protected against liquids. ANON. *Elec. World*, **97** [19], 888 (1931).—Its action, as water is thrown into the motor, is immediately to discharge it through the vent at the bottom of the center inclosing jacket. Air circulation is from both ends toward the center and out through this vent. G.R.S.

Material handling costs cut by electric trucks. C. B. CROCKETT. *Elec. World*, **97** [21], 950–53 (1931).—An outline is given of the tremendous diversity of products which have to be handled together with the widespread uses of the electric industrial trucks. Tables are given showing the savings effected by using electric lift trucks and the total cost per truck per month. G.R.S.

Improvement on trough feeders. ANON. *Tonind.-Ztg.*, **55** [18], 264–66 (1931).—New devices for obtaining a more even distribution of material in trough feeders are explained. M.V.K.

Modern clay mining. SCHWAMBERGER. *Tonind.-Ztg.*, **55** [41], 599–601 (1931).—A review of modern machines for clay mining in open clay pits is given and some small size shovels and dredging machines now in use in Germany are shown. W.M.C.

Mining, crushing, and grinding methods and costs at the Reliance Cement Rock Quarry of the Giant Portland Cement Co., Egypt, Pa. S. G. MCANALLY. Bur. Mines, *Information Circ.*, No. 6448, 17 pp. (1931). R.A.H.

BOOKS AND BULLETINS

List of Alloys. WILLIAM CAMPBELL. American Society for Testing Materials, Philadelphia, Pa. Paper $1.50; cloth, $2.00. *Can. Chem. Met.*, **15** [5], 80 (1931).—More than 2500 alloys are listed and in addition to their compositions, the physical properties of a number of typical alloys have been included. E.J.V.

Application of Interferometry. W. EWART WILLIAMS. Methuen and Co., London, 1930. 104 pp. Reviewed in *Jour. Phys. Chem.*, **35** [5], 1504 (1931); *Trans. Faraday Soc.*, **27** [5], 239 (1931); for abstract see *Ceram. Abs.*, **10** [6], 448 (1931). G.R.S.

Electrical Equipment. T. C. LLOYD. Reviewed in *Elec. World*, **97** [20], 922 (1931); see also *Ceram. Abs.*, **10** [6], 468 (1931). G.R.S.

Treatise on Leather Belting. GEO. B. HAVEN AND GEO. W. SWETT. Reviewed in *Elec. World*, **97** [20], 922 (1931); for abstract see *Ceram. Abs.*, **10** [6], 448 (1931). G.R.S.

Note on copper-constantan thermocouple calibration below 0°C. R. WIEBE AND M. J. BREVOORT. Bur. Mines, *Rept. of Invest.*, No. 3077, 7 pp. As a result of experimental work which is described, it was found that the deviation curve in connection with Adams or Southard and Andrews data from 0 to −193°C for copper-constantan thermocouples calibrated at the normal sublimation point of carbon dioxide and the normal boiling point of oxygen can apparently be represented by a quadratic equation: deviation $= ae + be^2$ with an accuracy of about 0.05°C. Experience with so-called "thermocouple" wire shows that in order to secure the above accuracy, each thermocouple must be calibrated individually. R.A.H.

Publications relating to friction and lubrication. ANON. Bur. Stand., *Letter Circ.*, No. 271. 4th ed. (Free.) 31 pp. April, 1931.—This letter circular lists all reports published by the Bureau dealing with friction and lubrication. R.A.H.

PATENTS

Brick meter. STUART M. PHELPS. U. S. 1,806,118, May 19, 1931. A three-dimension gage comprising opposite jaws of which one is movable relatively to the second, the second jaw including a tumbler movable from one to the other of two alternate service positions, and presenting in one such service position a single face opposed to the first-mentioned jaw, and presenting in the other service position two faces opposed to and spaced at unequal distances from the first-mentioned jaw.

Mine ventilating apparatus. LOUIS KESSLER. U. S. 1,806,760, May 26, 1931. In an apparatus for ventilating mines, a vertical discharge flue, a long lateral collecting pipe connected to the flue, the pipe decreasing in size as the distance from the flue increases, and a plurality of blowers arranged in and distributed along the pipe, the blowers decreasing in size as the distance from the flue increases.

Settling and classifying sand. JAMES MACDONALD MITCHELL. U. S. 1,807,125, May 26, 1931. In a sand settling and classifying apparatus, a frame, a receiver for liquid and sand mounted on the frame, a settling pocket communicating with the receiver and slidably mounted in the frame, flexible means connecting the pocket to the receiver, the pocket being provided with a discharge opening, a stationary valve mounted on the frame and seating in the discharge opening, a counter-balance lever pivoted on the frame and contacting at one end with the pocket, and means on the frame engaging the lever to prevent movement thereof until a predetermined quantity of sand has settled in the pocket.

Clay disintegrator. THEODORE C. AND WILLIS O. PROUTY. U. S. 1,808,509, June 2, 1931. In a disintegrator, a chamber provided with an axial inlet for material, a rotary member therein, concentric rows of stationary pins, other concentric rows of rotary pins carried by the rotary member, and inclined baffles in the intervals between pins of the stationary series and of the rotary series.

Accelerating the hardening of plastic materials. ALBERT BRUND AND HELGE BOHLIN. U. S. 1,808,762, June 9, 1931. The method of accelerating the hardening of a plastic mass having water therein which consists in passing an electric alternating current therethrough.

Lamination disintegrator. COSTANTE DALLA COSTE. U. S. 1,809,160, June 9, 1931. In a lamination disintegrator, a base, a groove in the base, means for attachment to an auger, and outstanding fingers at right angles to the longitudinal line of the base for the purpose specified.

Brick machine. JACOB NESSLY PORTER. U. S. 1,809,601, June 9, 1931. In a brick machine, the combination with brick-shaping means, a feed table, and a reciprocating member for successively feeding shaped brick along the table to one position, of means disposed forward of and in spaced relation to the member for moving each brick from the first referred-to position along the table to another position.

Making brick. GEORGE SCOTT HOUSMAN. U. S. 1,810,078, June 16, 1931. In an apparatus of the character described, the combination of a movable member having mold cavities located at intervals therein in which brick are adapted to be molded, means for effecting movement of the member at intervals, a plunger for subjecting the material in a mold cavity to a preliminary pressure of predetermined amount, and means for thereafter applying final pressure of predetermined amount to the material in the mold cavity, the final pressure being greater than the preliminary pressure.

Reducing to fine powder various materials and products such as enamels. JOSEPH LOUIS MARIE THOMAS. U. S. 1,810,800, June 16, 1931. Apparatus for reducing to fine powder various products, comprising a closed chamber, springs for the suspension of this chamber, a conical sieve in the chamber, dividing the latter in two superposed compartments, the upper compartment receiving the products to be pounded, and the lower

compartment being provided with suitable channels adopted to ensure the evacuation of the pulverized products, an anvil secured in the center of the sieve, a hammer having a hollow stem and adapted to reciprocate in the upper compartment and to strike upon the anvil, means for actuating the hammer, means for supplying, through the hollow stem of the hammer, compressed air on the anvil for projecting on the sieve the materials in proportion as they are pulverized, and ensuring the evacuation of these materials as soon as they have reached the desired degree of fineness.

Filter presses employed in the treatment of potters' clay, etc. E. W. MALKIN, G. E. LEESE, AND MANOR ENGINEERING CO., LTD. Brit. 346,964, April 29, 1931.

Ball or tube mills. E. G. STONE. Brit. 347,413, May 6, 1931.

Conveying apparatus for use in mines. A. WELSH, H. N. WOOD, AND G. RAW. Brit. 347,640, May 13, 1931.

Apparatus for measuring and testing the physical properties of materials. H. BRADLEY AND BRITISH BOOT, SHOE & ALLIED TRADES RESEARCH ASSN. Brit. 347,715, May 13, 1931.

Filter cloths. A. LEMAIRE. Brit. 348,016, May 20, 1931.

Apparatus for making ceramic products in a continuous manner. WILLY AND MAX LENGERSDORFF. Fr. 695,959, May 22, 1930. (*C.A.*)

Apparatus for drying ceramic products. MAISON F. FOUCHÉ. Fr. 696,648, June 4, 1930. (*C.A.*)

Jets for sandblast machines. RHEIN-RUHR MASCHINENVERTRIEB JACOBOVICS & NASSAU. Ger. 503,485, Sept. 15, 1926. The jet is made from tungsten carbide or other similar hard metallic substance or mixtures of these with other materials. (*J.S.G.T.*)

Sandblast nozzles. RHEIN-RUHR MASCHINENVERTRIEB JACOBOVICS & NASSAU. Ger. 505,757, Feb. 15, 1928. Addition to 503,485. A multipart nozzle of hard material such as tungsten carbide as set out in the original specification consists of at least two sections, the back one being conical, while the front one, *i.e.*, the discharge portion, is of conical form externally with a cylindrical hole. After being in use some time this is enlarged by abrasion to a conical bore when it is put in the rear position and a fresh front piece fitted. (*J.S.G.T.*)

Drying chamber for porcelain goods. GEBRÜDER NETZSCH. Ger. 521,099, Dec. 22, 1928. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Industrial electric furnaces. XII, XIII, XIV. The three-phase arc furnace. N. R. STANSEL. *Gen. Elec. Rev.*, **33**, 123–29, 316–22, 404–11 (1930).—A general description of the construction of the 3-phase arc furnace is given with a fairly detailed consideration of the refractory materials used. S. discusses the various factors which govern the successful and economical operation of this type of furnace. Particular attention is paid to the transformers which have been developed and are used in connection with these furnaces. Further details are given of the transformers used in connection with 3-phase electric arc furnaces. Special switching devices are described and details of the necessary electrical instruments given. (*J.I.M.*)

Electric kiln for firing ceramic ware. ANGELO CASTIGLIONI. *Ind. Silicati*, **9** [1], 12–14 (1931).—The advantages of the electric kiln over other types of kilns for firing ceramic ware are explained. M.V.K.

Laboratory kilns for obtaining higher temperatures. WERNER MYLIUS. *Sprechsaal*, **64** [12], 225–27 (1931).—(1) Three new horizontal tube kilns for the laboratory and a small crucible-fusing kiln are described in which high temperatures can be obtained with illuminating gas-air heating. (2) According to tests made, the following maximum

temperatures were obtained: In the crucible of the fusing kiln, 1600°C; in kiln 1 with a tube of about 25 mm. diameter, over 1650°; in kiln 2 with a tube of about 16 mm. diameter, over 1650°; in kiln 3 with a tube of about 38 mm. diameter, about 1470°C. (3) Tests were made on tube kiln 2 to determine the gas permeability of the tube which was made from Pythagoras mass. No penetration of carbon dioxide from the fuel gas through the walls into the interior of the tube was observed by gas volumetric tests even at 1600°. M.V.K.

Round kilns for high temperatures with overhead flame. LAMORT. *Feuerfest*, **7** [3], 38 (1931).—L. describes new round kilns with overhead flame built by the General Refractories, Ltd., in Sheffield, England. The kilns have a capacity of 25,000 block and are used for firing magnesite, chromite, and silica blocks; they reach a temperature of 1250 to 1520°C. In order to decrease the consumption of fuel, the walls of the kilns are covered with an isolating layer of diatomaceous earth 11.5 cm. thick. M.V.K.

Investigations of kilns for firing refractories. G. A. BOLE, J. BLIZARD, W. E. RICE, E. P. OGDEN, AND R. A. SHERMAN. *Ber. deut. keram. Ges.*, **12** [5], 257–72 (1931); for abstract see *Ceram. Abs.*, **6** [9], 395–96 (1927). E.J.V.

Tests on Hoffman kilns. A. CARENA. *Ind. Silicati*, **9** [2], 13–16 (1931).—Tests showed that the drying action of the hot air used for preheating the ware, and derived from the cooling chambers, varies in different zones of the drying chamber, and is greatest near the top. This defect was remedied by introducing the hot air at the bottom instead of at the top of the chamber. M.V.K.

Heat control of kilns. G. CAESAR. *Tonind.-Ztg.*, **55** [30], 434–36 (1931).—C. points out the necessity of heat control of kilns and describes the latest apparatus used for this purpose. M.V.K.

Heat transfer by conduction in ceramic kilns. ERICH SCHIRM. *Keramos*, **10** [4], 95–104 (1931).—Principles of heat transfer by conduction in ceramic kilns are discussed and different types of kilns are described. M.V.K.

Calculation of thermal characteristics of regenerators. K. RUMMEL. *Jour. Inst. Fuel*, **4**, 160–73 (1931).—The process of heat transfer in an experimental regenerator was studied. Measurements of temperature and resistance to flow were taken on different types of checkers and under varying conditions of operation. Practical simplified methods of calculation are derived and applied to the experimental data. See also *Ceram. Abs.*, **9** [8], 668 (1930). (*C.A.*)

Draft of chimneys and ventilators. C. GALLAUS. *Tonind.-Ztg.*, **55** [28], 411–12 (1931).—G. discusses the action of chimneys and ventilators in ceramic plants and points out that the great advantage of a chimney is that it does not require special mechanical power, the disadvantage being that it does not work uniformly and depends on weather conditions. The main advantages of ventilators are rapid firing and uniformity of the draft. A production increase of 50 to 60% may be obtained by the use of ventilators. M.V.K.

Glost firing of earthenware. WILHELM BACHER. *Keram. Rund.*, **39**, 23–25 (1931).—Elementary rules for placing the ware in saggers, filling the kilns, firing, and removing ware from the kiln are given. H.I.

Water-smoking channel in the masonry of the kiln. OTTO PHILIPP. *Tonind.-Ztg.*, **55** [23], 341–42 (1931).—To obtain efficient smoking, it is necessary that (1) the burning channel be sufficiently long, (2) the chimney or ventilator draft be strong enough, (3) the smoking channel be well arranged, (4) the overlying pipes be efficiently installed, (5) slides closed tightly and of good paper, and (6) care and intelligence be exercised in the management and control of the smoking process. These factors are discussed in detail and different plans of construction of the smoking channel are described. M.V.K.

Fans in the brick and lime industries. R. WITTE. *Tonind.-Ztg.*, **55** [36], 526–28 (1931).—The use of fans for kilns in the brick and lime industries to replace chimneys is discussed. W.M.C.

Fuel economy in small installations. W. F. RHODES. *Trans. Manchester Assn. Eng.*, pp. 57–95 (1927–28).—The choice of fuel for various purposes is discussed and tables are given of the chemical analyses, thermal values, and costs under standard conditions of firing of a number of different types of coal. Comparative data are given relating to the costs of coal, gas, and electricity. (*J.I.M.*)

Ignition of dried mixtures of carbon monoxide on silica. V. E. COSSLETT AND W. E. GARNER. *Trans. Faraday Soc.*, **27** [4], 176–88 (1931).—The ignition pressures, rates of the stationary reaction, and the percentage combustion were measured when dried carbon monoxide and oxygen mixtures were admitted to an evacuated silica vessel at 610°C. The effects of the addition of O_2, N_2, CO_2, Ar, and CO to the explosive mixture were studied. O_2 and Ar increase the ignitability of the gaseous mixture, whereas, N_2, CO, and CO_2 reduce the ease of ignition. A mechanism is given for the chain reaction in the gaseous phase which is in accord with the ignition phenomenon and with experiments on the chilling of flames in narrow cylindrical bombs. See also *Ceram. Abs.*, **10** [2], 137 (1931). G.R.S.

Heat economy of rotary kilns. SIGHARD HOERNER. *Tonind.-Ztg.*, **55** [32], 464–65 (1931).—H. discusses the heating process of rotary kilns treating (1) losses of heat in the kiln due to the nature of the heating process and amounting to about 60%, (2) preheating of air, and (3) heat transfer in the kiln and difficulties of increasing it. Different methods of increasing heat economy are discussed.. M.V.K.

Regulation of the speed of rotary kilns. E. AUERBACH. *Rev. mat. constr. trav. pub.*, No. 259, pp. 145–46 (1931); for abstract see *Ceram. Abs.*, **10** [3], 209 (1931). M.Y.H.

Graphical methods of fuel control. JAS. CUNNINGHAM. *Jour. Inst. Fuel*, **4**, 216–22 (1931).—C. shows that much of the fuel data entered into plant records can be used graphically to increase fuel economy. (*C.A.*)

Position of gas in the world's industries. J. E. WHITE. *Jour. Junior Inst. Eng.*, **40**, 52–61 (1929).—The increasing use of electricity as a means of industrial heating has stimulated the gas companies to further efforts to improve not only the efficiency of their own works, but also of the plant operated by their customers. W. has considered the subject from the point of view of the public undertakings, the coke-oven industry, and the industrialist who is already using or is contemplating the use of gas. An excellent account is given of the general principles involved in the use of gas under various conditions, high pressure, low pressure, and premixing. The discussion also covers the advantages of gas furnaces and their efficiency, wall thickness, size of the chamber, and of the combustion space. Finally, the various aspects of the preheating of the work, of the air, and of the gas, are reviewed. (*J.I.M.*)

Uniform gas current. ERICH OPPEN. *Tonind.-Ztg.*, **55** [32], 468–69 (1931).—An installation with nozzles for obtaining a uniform gas current is described. M.V.K.

Natural gas. J. L. SCOTT. *Clay-Worker*, **95** [5], 342–43 (1931).—In a few notes on the proper utilization of natural gas and the economies that lie therein, it is pointed out that if subjected to slip-shod methods of application, natural gas is so expensive that its use in the firing of brick and tile is entirely out of the question. When the many good qualities of natural gas are intelligently utilized, gas-fired kilns produce better ware at an actual fuel cost equal to or slightly less than that of coal. Illustrated. E.J.V.

Supervision of generator performance and gas firing. ANON. *Keram. Rund.*, **39**, 10–12 (1931).—The use of continuous gas recorders enables the foreman to make necessary changes in dampers, etc., to provide high-quality gas, and provides stokers,

etc., with an efficient watchman during the night shift. Economies in fuel consumption and improvements in quality and quantity of ware are afforded through its use.

H.I.

Influence of firing temperature and furnace gases on the development of ceramic colors and glazes. E. BERDEL. *Farben-Chem.*, **1**, 13 (1930); **2**, 12 (1931).—The firing technique is described in general outline for the different classes of ware in relation to the various methods of decorating pottery, *viz.*, colored engobes or slips, colored glazes, and on glaze and underglaze colors. The subject is treated under the headings, brick and coarse pottery, majolica and faience, earthenware, vitreous earthenware (stoneware), and porcelain. (*Trans. Ceram. Soc.* [Eng.])

Modern oil firing. R. O. NASH. *Jour. Operative Brewers' Guild*, **16**, 99–109 (1928).—Read before Lancashire Section. The relative advantages of the pressure, steam, and air-jet systems are discussed and particulars are given of most of the leading examples of each type. Particular reference is made to applications of oil firing in breweries and the advantages obtained are specified. Applications to metallurgical furnaces are described, notably rivet heating, tube welding, bolt and nut manufacture, metal melting, and billet heating. In many cases detailed cost particulars are given. Some mistakes made in applying oil firing to boilers are pointed out. (*J.I.M.*)

Coal components as seen through the microscope. ANON. *Chemicals*, **35** [22], 31(1931).—Coals are composed essentially of two visibly different major components, anthraxylon and attritus, which are present in different types of coal in greatly varying proportions. Anthraxylon is a structurally simple component, while attritus is a complex component, composed of a large number of plant entities. In addition to these, there is a third minor component, called fusain or "mineral charcoal," found in most coals in relatively small proportions. The appearance of each of these under the microscope is discussed. G.R.S.

Combustion of Illinois coals. ALONZO P. KRATZ AND WILBUR J. WOODRUFF. *Colliery Guard.*, **142** [3674], 1908 (1931); for abstract see *Ceram. Abs.*, **10** [4], 292 (1931).

E.J.V.

Some elements of the fly-ash problem. H. H. BUBAR. *Elec. World*, **97** [21], 961–62 (1931).—The solution of the fly-ash problem lies in reducing the amount of ash that is discharged to the atmosphere to the point where it is no longer objectionable. Under operating conditions of pulverized fuel firing an average of 70% of the total ash in the coal goes up the stack. This dust averages more than 85% through a 300-mesh screen. Typical screen analysis of fly-ash is shown and the distances that different-sized particles will travel after leaving the stack are calculated. G.R.S.

BOOKS

Applied Electrothermics. (Electrothermie appliquée.) G. FLUSIN. Baillière, Paris, 1930. 380 pp. Price 70 F. Reviewed in *Giorn. chim. ind. applicata*, **13** [2], 100–101 (1931).—The calculation and application of chemico-physical data pertaining to electrothermics are given in the first part of the work. The chapter on heat loss is notable as are the experiments on the effect of coating the exterior of furnaces with aluminum. The second part of the work deals with the manufacture of carbon and graphite electrodes. M.V.K.

Flow and Measurement of Air and Gases. ALEC B. EASON. 2nd ed. 254 pp. C. Griffin and Co., Ltd., London. Reviewed in *Trans. Faraday Soc.*, **27** [5], 236–37 (1931). G.R.S.

PATENTS

Furnace. FRANK W. BROOKE. U. S. 1,807,147, May 26, 1931. In a continuous, direct, electric-resistance heating furnace, a plurality of material conveying means

arranged in substantially parallel horizontally extending paths, a support mounted between the paths and extending through the bottom of the furnace, an electric-resistance heating unit mounted on the support, and means for lowering the support with the heating unit thereon clear of the material conveying means to a point without the furnace.

Sectional buckstay. JOHN P. MCLIMANS. U. S. 1,809,210, June 9, 1931. A furnace construction comprising, in combination, a plurality of side walls, and a plurality of vertically extending buckstays associated with the side walls and arranged to reinforce the same, the lower portions of the buckstays being rigidly affixed in place and the upper portions thereof being separable from the lower portions to permit ready removal.

Kiln for firing brick, etc. ALOIS HABLA. U. S. 1,809,336, June 9, 1931. A brick kiln comprising long, spaced, and substantially parallel walls, division walls of unfired open brickwork extending partly across the space alternately from the long walls to form a sinuous passage from end to end of the kiln, means to supply gases to the kiln, a portion of the gases passing through the sinuous passage and another portion passing directly through the division walls.

Gas-fired kiln. PETER J. LENGSHOLZ. U. S. 1,810,616, June 16, 1931. Firebox construction for gas-fired kilns, including a bottom wall, side walls, and a bag wall, a perforate wall spaced from the bottom wall extending between the side walls terminating short of the bag wall and a front wall extending between the side, bottom, and perforate walls forming a mixing chamber, gas- and air-supply lines leading to the mixing chamber, a second perforate wall spaced from the perforate wall extending between the side walls and a second front wall extending between the side and perforate walls forming a primary combustion chamber, and a third front wall extending between the side walls and above the second perforate wall forming with the bag wall, second perforate wall, and side walls a secondary combustion chamber.

Wall structures. HARROP CERAMIC SERVICE CO. Brit. 348,057, May 20, 1931.

Tunnel ovens. J. DANIELS. Brit. 348,225, May 20, 1931.

Metal stands for supporting pieces of pottery while being fired in a kiln. T. SIMPSON AND W. SYLVESTER. Brit. 348,245, May 20, 1931.

Tunnel kiln for brick. VOJTĚCH LAŠTOVIČKA. Austrian 120,977, Aug. 15, 1930; see also *Ceram. Abs.*, **10** [3], 220 (1931). (*C.A.*)

Furnace for baking tile, etc. SOC. SEEDORFF-BARFRED-GEORGE. Fr. 696,210, May 28, 1930. (*C.A.*)

Geology

Fundamentals and economies in the clay industries. V. ELLIS LOVEJOY. *Clay-Worker*, **95** [5], 346–47 (1931).—Flint fire clays are alike in composition and widely different in physical properties when compared with plastic clays. The characteristic properties of flint clays are enumerated and several theories regarding the formation of these clays are discussed. One widely accepted theory is that the flint clays are due to complete crystallization of the kaolinite, partial crystallization in the semiflints, and less or none in the plastic clays. The most recent theory is that flint clays are a silica-bonded bauxite or bauxitic clay having practically the same composition as a true clay, but which has lost the plasticity of the clay from which it developed. For Part IV see *Ceram. Abs.*, **10** [7], 499 (1931). E.J.V.

Crystallization of pyroxenes from basalts. T. F. W. BARTH. *Amer. Mineralogist*, **16** [5], 195–208 (1931).—Pigeonite is the most abundant pyroxene in volcanic rocks. Pyroxenes crystallizing from a basaltic magma exhibit a regular sequence of crystalliza-

tion from diopsidic to hypersthenic, during which the content of $MgSiO_3$ may remain constant or increase slightly. G.R.S.

Chemical and optical study of the black tourmalines. G. W. WARD. *Amer. Mineralogist*, **16** [4], 145–90 (1931).—Microscopic studies were made of 174 specimens of black tourmaline. From chemical analyses the tourmalines were shown to agree fairly well with Rammelsberg's formula, $(R_6SiO_5)_x$. The acid from which all tourmalines are derived is represented by $H_{20}B_2Si_4O_{21}$. The complexity and number of possible substitutions for the H and other atoms are disputed points. Possibly X-ray work may prove suggestive but the data at present are too complex to permit representation by any simple formula. Variation in chemical composition is independent of geologic occurrence. Values below 1.662 for ω gave light colors in the pleochroic formula. Relationships between chemical composition and optical data were plotted. An increase in indices and birefringence is largely due to increase in total iron. G.R.S.

Composition of the alkali amphiboles. H. BERMAN AND E. S. LARSON. *Amer. Mineralogist*, **16** [4], 140–44 (1931).—About 100 analyses were examined and a preliminary result of the chemical studies is given. Using the conclusions based on analyses as to the isomorphous replacements, a modification of Warren's formula is $(Ca,Na)_2$-$Na_{0-1}{\cdot}Mg_1(Mg,Al)_4\,(Al,Si)_2Si_6O_{22}(O{\cdot}OH,F)_2$. Those elements within parentheses are completely replaceable. The others can be considered as being fixed (with the exception that Fe'' and Fe''' may replace Mg and Al, respectively). The ratio of Mg:Al:Si is shown in a triaxial diagram, on the assumption that in all amphiboles the sum of these three is constant. G.R.S.

Earth pigments. E. C. WOOD AND E. A. KIEFER, JR. *Chemicals*, **35** [22], 11 (1931).—The pigments, red oxide of iron, ocher, sienna, and umber, are composed chiefly of clay permeated by hydrated iron oxide, which together with the manganese present in sienna and umber furnishes the color. Production in the U.S. is shown as well as the amount imported. G.R.S.

Schairerite, a new mineral from Searles Lake, California. W. F. FOSHAG. *Amer. Mineralogist*, **16** [4], 133–39 (1931).—Analysis gives the formula $Na_2SO_4{\cdot}Na(F,Cl)$. The mineral is characterized by low index of refraction (ω = 1.440, ϵ = 1.445) and an extremely low birefringence. The crystals, appearing as steep trigonal rhombs, are slowly but completely soluble in water. They fuse easily to a white porcelaneous mass. Hardness = $3^1/_2$ and specific gravity = 2.612. Diagrams and crystallographic measurements are given. G.R.S.

Microcline locality in Maine. E. S. C. SMITH. *Amer. Mineralogist*, **16** [4], 191 (1931).—A brief description is given of the deposit of microcline on the Island of Mount Desert, Maine. G.R.S.

Value of ceramic tests in subsurface correlation of cretaceous shales in central Wyoming. C. E. DOBBIN AND E. A. SWEDENBORG. *Mining & Met.*, **12** [294], 10 (1931).—Experiments indicate that firing under carefully controlled conditions develops physical characteristics that appear to be diagnostic of the part of the geologic columns from which they came. They identify the position in the geologic section when the cuttings yield neither lithologic nor paleontologic criteria that will permit correlations. E.J.V.

Canadian silica. ANON. *Chem. News*, **142** [3709], 308 (1931).—The materials produced in the silica mining industry are (1) silica sand for the manufacture of glass, (2) silicon carbide, (3) for use in steel foundries, silex, the finely pulverized silica sand which is important as a grinding and polishing substance, (4) quartz and quartzite for smelter flux, (5) ferrosilicon, and (6) silica brick. G.R.S.

Pneumatolytic synthesis of silicates. I. C. J. VAN NIEUWENBURG AND H. B. BLUMENDAL. *Rec. trav. chim.*, **50**, 129–38 (1931).—On the basis of previous experiments

on the volatilization of SiO_2 by steam above its critical temperature, silicates have been synthesized by placing the metal oxide and SiO_2 in separate crucibles and heating them in an autoclave with steam at temperatures of about 365° and pressures of 200 to 250 atmospheres. In this way β-wollastonite, Sr metasilicate, alamosite, illemite, tephrosite, antigorite, and diopside have been prepared. Such syntheses may be significant from a geological point of view. Ferrosilicide may, in general, be used instead of SiO_2. See also *Ceram. Abs.*, **10** [2], 152 (1931). (*C.A.*)

Plaster from the geological point of view. V. CHARRIN. *Rev. mat. constr. trav. pub.*, No. 258, pp. 99–101 (1931).—C. describes the geological formation of the gypsum deposits of France. M.Y.H.

Feldspar deposits of Trollhättan. R. LOOSTRÖM. *Keramos*, **10** [8–9], 221–25 (1931).—L. describes the rich feldspar deposits of Trollhättan, Sweden. Data on the chemical composition and properties are given. M.V.K.

Quartz deposits in Bohemia. WILHELM HANNICH. *Keramos*, **10** [5–6], 145–47 (1931).—A description of a large deposit of quartz, containing 99.5% silicic acid, situated in Böhmish-Leipa, Bohemia, is given. M.V.K.

Quartz of the Urals. M. G. GORDIENKO. *Gorniy Jour.; Tonind.-Ztg.*, **55** [21], 316 (1931).—The quartz deposits of the Ural are estimated at 3,780,000 T., but only 16 of 69 deposits are being worked. The quartz has been classified as follows: Type O, pure quartz, contains 99 to 99.5% silicic acid and not more than 0.35% Fe_2O_3 and is to be used in the porcelain industry. Types I and II contain at least 98% silicic acid and not more than 1% Fe_2O_3, and are used in the chemical and refractory industries. Type III consists of pieces of 25 cc. diameter, contains 94 to 96% quartz and 2% impurities, and is used in copper metallurgy. Pure rock crystal is used for optical instruments and impure crystal for the manufacture of quartz glass. M.V.K.

Removing the iron of Hungarian sands. I. L. DE PUTNOKY AND B. BOBEST. *Magyar Mérnök. Epit. Közlönye*, **65**, 63–70 (1931).—Five Hungarian sands were examined for Fe content and means for reducing it to an amount which does not prevent the use of the sand in glass, ceramic, etc., industries. By washing sands with 2 *N* HCl, about 25% of the original Fe was removed. HCl (0.5 *N*) removed only 10 to 12% of Fe. HCl also dissolves $CaCO_3$; thus sands containing lime lose much weight and contain relatively even more Fe after washing than originally. HCl attacks the limonite crust of sand particles, but it cannot dissolve grains of siliceous Fe. On washing with water, a sample from Mountain Mátra gave fairly pure quartz, containing 0.2% Fe_2O_3 and 93.6% SiO_2 with some Al_2O_3 and no CO_2. Other methods for Fe removal are under examination. (*C.A.*)

BOOKS AND BULLETINS

Examination of Fragmental Rocks. F. G. TICKELL. Stanford Univ. Press, Palo Alto, Calif. 128 pp., illustrations. Price $5.00. *Mining & Met.*, **12** [294], 18 (1931).—The first three chapters deal with size analysis, porosity, permeability, and the preparation of specimens of sedimentary rocks and loose aggregates. Chapter IV deals with the identification of minerals by means of crystallography and optical properties with a brief section on arc spectra. Chapter V describes minerals. E.J.V.

Bibliography of North American geology, 1919–1928. J. M. NICKLES. iii + 1005 pp. Geological Surv., *Bull.*, No. 823. Supt. of Documents, Govt. Printing Office. Price $1.25. A cumulation of the 4 bibliographies already published for 1919–1926 with the addition of that for 1927–28, not previously published. The convenience of having a 10-year bibliography under one cover and in one alphabetic arrangement is obvious. Bulletins 746 and 747 and this volume together give a complete conspectus of writings on North American geology from 1785 to the end of 1918. They are invaluable to every geologist in active service. R.A.H.

Applied Geophysics. H. SHAW, J. McG. BRUCKSHAW, AND S. T. NEWING. Board of Education, Science Museum Pub., H.M. Stationery Office, London, 1931. 101 pp., 10 plates. *Mining & Met.*, **12** [294], 16 (1931); see also *Ceram. Abs.*, **9** [11], 975 (1930). E.J.V.

Geological Map of the World. FRANZ BEYSCHLAG. Gebrüder Borntraeger, Berlin, 1929. Price 150 Rm. *Mining & Met.*, **12** [294], 18 (1931).—This is a map on the scale of 1:15,000,000 and is in colors with an explanatory geological section. E.J.V.

Borax Industry of Tuscany. (Italian.) RAFFAELO NASINI. Pp. xi + 658. Rome, 1930. Reviewed in *Analyst*, **56**, 215–16 (1931).—The processes of the Soc. Boracifera di Lardarello for recovering boron and other compounds from volcanic soffioni and lagoons are described. H.H.S.

Hafnium. PAUL M. TYLER. Bur. Mines, *Information Circ.*, No. 6457, 11 pp. (1931).—The report discusses the occurrence, description and properties, identification, geographical distribution, separation of zirconium and hafnium, preparation of pure hafnium salts, and possible uses for the comparatively recently discovered element named hafnium. R.A.H.

Geophysical abstracts. XXIII and XXIV. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6461, 25 pp.; No. 6478, 25 pp.—Monthly reviews are given of recent articles on the development of geophysical methods of prospecting; for Part XXII see *Ceram. Abs.*, **10** [6], 457 (1931). R.A.H.

PATENT

Ceramic noble metal preparations. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Ger. 515,588, Oct. 14, 1927. Noble metal preparations for decorating and coloring ceramic ware are obtained from dispersions of the metal or its compounds in cellulose derivatives, in the presence or absence of solvent and flux. Thus, a 30% $AuCl_3$ solution in alcohol is stirred into a solution of nitrocellulose in ethyl-glycol and cyclohexanone. Several additional examples are given. The method is stated to be applicable to all metals. (*C.A.*)

Chemistry and Physics

Interrelationships of certain single-valued soil properties. G. B. BODMAN AND ESTHER P. PERRY. *Soil Sci.*, **31** [5], 365–78 (1931).—Measurements of several single-valued soil properties, *i.e.*, colloid content by adsorption, clay finer than 2μ and clay finer than 1μ following treatment with hydrogen peroxide and HCl, clay finer than 1μ following shaking with ammonia water, air-dry moisture content, moisture equivalent, sticky point, and rolling-out limit, were made with a large variety of soils. A comparison of the results for the measurement of colloid by adsorption and clay fractions representing different upper size limits, showed that the adsorption method gave higher results on the whole than were obtained for a measure of the peroxide-HCl dispersed clay finer than 2μ, and that the clay finer than 1μ constituted on the average nearly 90% of the total clay having 2μ as the upper limit for soils of varying clay content. The ammonia pretreatment yielded much lower quantities of clay finer than 1μ than did the peroxide-HCl pretreatment. The results indicate that the international method of dispersion and analysis does not permit complete expression of the probable colloidal content of a soil, possibly because of indispersible colloid shells at the particle surface, and because of the presence of micropores, neither of which is taken into account by a mere expression of size distribution. Significantly high correlations were found to exist between (1) the moisture equivalent and the sticky point, (2) moisture equivalent and colloid, (3) colloid and sticky point, (4) moisture equivalent and nonsticky range, (6) colloid and air-

dry moisture content, (7) colloid and clay finer than 2μ, and (8) moisture equivalent and rolling-out limit, these being arranged in descending order of their correlation coefficients. No significant correlation was found between clay and rolling-out limit.

G.R.S.

Nature of soil acidity as affected by the SiO_2-sesquioxide ratio. L. D. BAVER AND G. D. SCARSETH. *Soil Sci.*, **31** [3], 159–73 (1931).—Colloidal material has been isolated from 21 different soils representing various kinds and states of weathering. The SiO_2-sesquioxide ratio, the total exchange capacity, and the nature of the soil acids have been determined on these colloids. The following results were obtained: The nature of soil acids varies considerably in different soils. In weathered soils their nature is solely a function of the kind and extent of weathering and is independent of the parent material. This indicates that there is more than one type of soil acid. Colloidal material extracted from soils that are well weathered and that have a high SiO_2-sesquioxide ratio, tends to be more highly buffered and exhibits stronger acidity than those colloids having a low ratio. Their total exchange capacity is higher. The buffer capacity of the colloids appears to be primarily a function of the nature of the soil acid. The nature of the soil acids may prove to be valuable criteria in the classification of soils. The exchange complex may develop by removal of certain constituents from the original alumino-silicate minerals; by mutual flocculation of the colloidal oxides of Al, Fe, and Si; and by the precipitation of Al, Fe, and Si from the solution. There is no one direct relationship between the SiO_2-sesquioxide ratio and the total exchange capacity of the colloid or the nature of the soil acid. Three different groups appear to be manifested in which a direct relationship between these factors is indicated. It is suggested that this may be due to different types of exchange complexes or to the presence of free oxides of Al, Fe, and Si. G.R.S.

Laws of soil colloidal behavior. IV. Isoelectric precipitates. SANTE MATTSON. *Soil Sci.*, **31** [1], 57–77 (1931).—This, the second paper on isoelectric precipitates, deals with the "humates," "phospho-humates," "silico-humates," and "phospho-silicates" of aluminum and iron. The "humates" differ from the "silicates" and "phosphates" in that the colloidal humic complex is quantitatively precipitated by the $AlCl_3$ and $FeCl_3$ and in showing an electropositive maximum on the acid side of the isoelectric point. The ferric "humates" are isoelectric at a much lower p_H than the aluminum "humates" of corresponding composition. The humate ion, or ion complex, displaces the PO_4 ion and, to a still greater extent, the SiO_3 ion. The PO_4 ion strongly displaces the SiO_3 ion. There is no apparent displacement of the PO_4 ion by the SiO_3 ion, for in the presence of the latter the proportion of the P_2O_5 in the complex increases. This anomaly may be due to the formation of an addition complex and will be discussed later in connection with aluminum and iron-forming isoelectric precipitates in the same manner as the humus complex. **V. Ion adsorption and exchange.** *Ibid.*, **31** [4], 311–31 (1931).—The cation exchange capacity of isoelectrically precipitated "silicates," "phosphates," and "humates" of aluminum and iron of varying composition ratios has been studied and compared with that of natural soil colloids of varying silica/sesquioxide ratios. The exchange capacities, at p_H 7.0, increase with the proportion of acidoid (SiO_2, P_2O_5, and humus) to ampholytoid (sesquioxides) in all the materials studied. The ferric complexes show a higher cation exchange capacity than the corresponding aluminum combinations. The differences are explained on the assumption that the acidoid and ampholytoid constituents exist in partial combination with one another, resulting in compounds which are at the same time both acidic and basic. The free acidoid valences, uncombined with the ampholytoid valences constitute the seat of cation exchange. The exchange capacity is not a constant quantity but can be altered by a shifting of the bonds. The electronegative complexes give an exchange acidity with neutral salts whereas the electro-

positive complexes give an exchange alkalinity. The point of exchange neutrality does not coincide with the isoelectric point but varies with the nature of the ions of the salt. The Donnan equilibrium shows the micellar atmosphere to consist of cations in the electronegative condition and of anions in the electropositive condition, but the cataphoretic and the Donnan isoelectric points do not appear at exactly the same p_H.

G.R.S.

Conception of flow plasticity as applied to soils. G. W. Scott Blair. *Soil Sci.*, **31** [4], 291–98 (1931).—A brief description is given of the way in which flow plasticity is measured, and the relationship between flow-data in general and plasticity in the sense defined by Wilson is discussed. It is claimed that flow plasticity should give an interesting test for studying changes taking place in the physical properties of soils. Three cases where changes are caused by (1) addition of chalk and lime, (2) the normal leaching process, and (3) addition of sand to a heavy soil have been investigated and are quoted. It is shown that the plasticity of a soil is diminished by the addition of lime and chalk.

G.R.S.

Estimating total exchangeable bases in soils. A. N. Puri. *Soil Sci.*, **31** [4], 275–79 (1931).—A method for the estimation of total exchangeable bases consists in the determination of carbonates by P.'s titration method, and of total bases by dilute HCl treatment, the difference between the two values giving the exchangeable bases. The results of such determinations on 49 soils from different parts of India are recorded. See also *Ceram. Abs.*, **10** [3], 206 (1931).

G.R.S.

Adsorption of chlorides of aluminium and thorium by clays and kaolins. N. A. Held. *Jour. Russ. Phys.-Chem. Soc.*, **62**, 1553–70 (1930).—H. studied the character of adsorption of these salts by 5 kinds of Russian clays and made a number of electrometric titrations of the ions of $AlCl_3$ and $ThCl_4$. A number of tables and curves show that Cl^- is adsorbed in negligible quantities, while Al and Th are adsorbed in different proportions by different clays (from 1 to 10 times). The general character of adsorption shows that with increased concentration of the cation, the quantity adsorbed approaches a limit and seemingly satisfies the isothermal adsorption equation of Freundlich. The cations Ca^{++} and Mg^{++} substitute Al^{+++} and Th^{++++} in the solution, *i.e.*, substitution adsorption takes place. It is suggested that the clays can be characterized by the amounts of adsorbed aluminosilicates. Displacement of hydrolytic equilibrium results in acidity of the solution. The hydrolysis is expressed by $AlCl_3 + 2H_2O \rightleftharpoons Al(OH)_2Cl + 2HCl$. $ThCl_4 + 3H_2O \rightleftharpoons Th(OH)_3Cl + 3HCl$. Determined constants for the hydrolysis of $AlCl_3$ at 20° range from 1.1×10^{-9} to 1.95×10^{-9}, at 25° from 2.5×10^{-9} to 3.6×10^{-9}; for $ThCl_4$ at 20° 5.5×10^{-11} to 5.9×10^{-11}. (*C.A.*)

Effect of hydrogen-ion concentration in the adsorption of ions of barium, aluminium, and thorium by clays. N. A. Held and M. N. Sokolova. *Jour. Russ. Phys.-Chem. Soc.*, **62**, 1571–75 (1930).—Glukhov kaolin adsorbs Ba ion from solutions of $Ba(OH)_2$ to a much larger extent than OH ion; Ca ion enters the solution instead of Ba; therefore this is a case of substitution adsorption. This satisfies Freundlich's equation $x/m = \alpha C^h$. Comparison of adsorption of Ba from solutions of $Ba(OH)_2$, $BaCl_2$, and $BaCl_2$ + HCl shows a decrease of adsorbed Ba with increase of H ion concentration. In agreement with this, Th ion is adsorbed less than Al ion and less than Ba ion from solutions of equal concentration as its hydrolysis results in a higher concentration of H ions.

(*C.A.*)

Structure of β alumina. W. L. Bragg, C. Gottfried, and J. West. *Z. Krist.*, **77** [3 & 4], 255–74 (1931).—Alumina appears to exist in four forms (α, β, γ, and δ) of which the α form (corundum) is alone stable at high temperatures (about 1000°C). Of the other forms δAl_2O_3 appears to possess the corundum structure with a much expanded lattice. The γ form suggests a spinel structure. βAl_2O_3 crystals develop ac-

cidentally during slow cooling of molten alumina, their formation being assisted by the presence in small quantity of such substances as MgO and Na_2O. The structure is hexagonal with axes $a = 5.56$Å, $c = 22.56$Å. Physical properties of the crystal indicate holohedral symmetry and the X-ray examination suggests the space group D^4_{6h}. A description is given of the structure which was adopted with reservations. G.R.S.

Alumina-silica system and its relation to ceramic engineering. HEWITT WILSON. *Bull. Amer. Ceram. Soc.*, **10** [6], 152–59 (1931).—After a brief historical survey of the alumina-silica system, W. discusses briefly the specific ceramic fields covered by the diagram of this system. E.J.V.

Separation of iron-titanium-aluminum in tartrate solution. ERICH SCHWARZ VON BERGKAMPF. *Z. anal. Chem.*, **83**, 345–50 (1931).—A satisfactory separation of Fe, Al, and Ti (corresponding to 0.084 g. Fe_2O_3, 0.018 g. TiO_2, and 0.07 g. Al_2O_3) was accomplished by first reducing the Fe^{+++} with H_2S in acid solution, making slightly ammoniacal and precipitating FeS with H_2S, making acid with H_2SO_4 and precipitating Ti with cupferron, and finally precipitating Al with oxine acetate in ammoniacal solution. The presence of V caused trouble. (*C.A.*)

Volumetric determination of magnesia and alumina in minerals and refractory brick. H. ECKSTEIN. *Chem.-Ztg.*, **55**, 227 (1931).—For the determination of magnesia, the filtrate from the ammonia precipitate in the ordinary course of analysis is boiled with 3 to 5 g. of ammonium chloride, 2 cc. of ammonia, and 15 cc. of 3% 8-hydroxyquinoline solution. The yellow precipitate is collected, washed with hot dilute ammonia, redissolved in hydrochloric acid, and reprecipitated as before. The second precipitate is dissolved in dilute hydrochloric acid, and the solution is titrated with 0.1 *N*-potassium bromide-bromate, using a 1% solution of indigo-carmine as indicator (1 cc. of 0.1 *N*-KBr-$KBrO_3$ = 0.000504 g. MgO). Alumina may be determined in refractories by fusing 0.5 g. of the finely-ground material with 5 g. of fused borax, dissolving the fusion in dilute hydrochloric acid, diluting to 250 cc., and treating 25 cc. with ammonia to neutrality; a few drops of hydrochloric acid, 5 g. of sodium acetate, water to 100 cc., and 3% 8-hydroxyquinoline solution in slight excess are needed to precipitate the alumina. The washed precipitate is dissolved in hydrochloric acid and the solution titrated as for magnesia (1 cc. = 0.000425 g. Al_2O_3). (*B.C.A.*)

Determination of alumina in refractory clays. R. BIAZZO. *Ann. Chim. Appl.*, **21**, 3–12 (1931).—When the only determination required is that of the alumina, the calcined residue of the clay, which contains most of the aluminum and iron as noncolloidal anhydrous oxides, is treated with hot dilute nitric acid, thus dissolving the basic aluminum and iron salts without attacking the oxides. After addition of ammonium nitrate and ammonia, the undissolved oxides and the precipitated hydroxides are collected, rapidly washed, and calcined. The ferric oxide in the weighed mixed oxides is then determined separately as usual. (*B.C.A.*)

Electrodeposition of chromium. W. W. SHISHKIN AND E. W. GERNET. *Messenger Metal Ind.* [Russia], No. 12, pp. 13–26 (1927); No. 1, pp. 7–21 (1928).—A solution of pure chromic acid containing 250 g. of CrO_3/liter, with 2 to 3 g. of sulphuric acid and some Cr''', so that the ratio, $Cr''':Cr^{VI} = 1:20$, represents a good chromium electrolyte. For a bright deposit, the higher the temperature the higher must be the current density. The best conditions in practice are 45°C and a current density of 10 to 12 amperes/dm.^{2}. For such deposits the deposition efficiency is not high. If the temperature is lowered, mat deposits are obtained with the same current density, the efficiency increasing at the same time. At temperatures below 8°C the deposits have a brown color. With moderate current density the deposits are perfectly homogeneous and adherent and can easily be polished (even if brown). With a low concentration of chromic acid, bright deposits are obtained, whereas with a high concentration, such deposits are only

possible with a low current density. The curve of decomposition of chromic acid in the presence of SO_4'' ions has two branches, one of which represents the reduction of chromic acid and the other the evolution of hydrogen and chromium. The abrupt transition from the first to the second causes a drop in the current. This transition is impeded by raising the temperature, increasing the SO_4'' content, and stirring the electrolyte. As a result of the examination of the deposits, it is considered that the metal is evolved by the discharging of the metal cations of low valency from the partially reduced chromic acid. (*J.I.M.*)

Crystalline structure of chromium deposits. R. J. PIERSOL. *Metal Cleaning & Finishing*, **3** [5], 369–74 (1931).—A discussion of the factors which influence the crystalline structure of electrodeposited chromium is presented. E.J.V.

Ternary system K_2O–CaO–SiO_2: a correction. G. W. MOREY, F. C. KRACEK, AND N. L. BOWEN. *Jour. Soc. Glass Tech.*, **15** [57], 57–58 (1931).—The crystals with $\gamma = 1.59$, $\alpha = 1.575$ were called a disilicate, but further study shows their composition to be $K_2O{\cdot}3CaO{\cdot}6SiO_2$, crystallizing in two enantiotropic modifications. The β-form has the optical and crystallographic properties given for $K_2O{\cdot}3CaO{\cdot}6SiO_2$, while the high-temperature or α-form has the properties previously given for $K_2O{\cdot}2CaO{\cdot}6SiO_2$. No compound of the latter composition exists. The transition from β- to α-form takes place readily, but the reverse change is slow. A corrected list of omissions and misprints in the previous paper is given. For previous paper see *Ceram. Abs.*, **9** [10], 880 (1930). G.R.S.

System P_2O_5–CaO–H_2O and the recrystallization of monocalcium phosphate. N. A. CLARK. *Jour. Phys. Chem.*, **35** [5], 1232–38 (1931).—An examination was made of parts of the space model for the system CaO–P_2O_5–H_2O as drawn by Bassett, and the indicated behavior of monocalcium and dicalcium phosphates in solution was investigated. Methods for the recrystallization of the monocalcium phosphate are given. G.R.S.

Microdetermination of calcium and magnesium in the presence of each other. K. L. MALYAROV. *Mikrochemie*, **3**, 132–35 (1931).—If not over 10 mg. of CaO or MgO (as carbonate, oxide, or hydroxide) and only very little, if any, alkali carbonate is present, a satisfactory separation and determination can be accomplished by taking advantage of the fact that CaO is quite soluble in water and MgO is not appreciably soluble. Ignite the sample for some time, preferably over the blast lamp, cool in a desiccator over soda lime or KOH and then dissolve the CaO by means of 60 to 80 cc. of hot water free from CO_2. Filter and titrate the filtrate with 0.05 to 0.02 *N* HCl with methyl orange as indicator. Dissolve the residual MgO in a measured volume of the HCl and titrate the excess acid with NaOH. (*C.A.*)

Determination of calcium and magnesium by titrating in the same solution. K. L. MALYAROV. *Jour. Russ. Phys.-Chem. Soc.*, **62**, 1529–31 (1930).—Ca is precipitated by means of oxalic acid, and then, without filtration, Mg is precipitated as hydroxide from the same solution by means of KOH. The two can then be determined microanalytically, without separation, in the following way: Mg is determined by titrating with H_2SO_4, and Ca is determined by titrating with $KMnO_4$. The solution, however, must be free from NH_4 salts, and the amount of MgO must not exceed 0.01 g. (*C.A.*)

Influence of the conversion method on the iron determination in refractory materials. ROBERT STUMPER. *Arch. Eisenhüttenwesen*, **4** [9], 439–41 (1930–31); *Stahl Eisen*, **51** [18], 571 (1931).—S. discusses the determination of the absorption of iron by a platinum crucible during conversion of refractory materials in a reduced gas atmosphere, and the fixation of a suitable conversion method. M.V.K.

New method for the titration of iron according to J. Knopp. OTTO ROTHE AND AGGÊO PIO SOBRINHO. *Rev. brasil. chim.*, **1**, 129–49 (1929).—For determining Fe^{++},

the following conclusions are drawn: The use of diphenylamine indicator with dichromate is superior to the use of permanganate. The metals of the second group must be removed with H_2S, especially As and Sb. Minute quantities of Cu cause no error. Colloidal silica or other metals such as Hg and Sn need not be removed. Colloidal Pt caused by fusion of the oxide in a Pt crucible is harmful, making the use of permanganate necessary. An Ag crucible is to be preferred. Care must be taken not to reduce any AgCl, the reduction of which takes place quite readily. (*C.A.*)

Dithizon "spot" tests with heavy metals. H. FISCHER. *Mikrochemie*, **8**, 319–29 (1930); *Analyst*, **56**, 208 (1931).—A dilute solution of "dithizon" (diphenylthiocarbazone) in CCl_4 or CS_2 is green. Cu changes it to brown; Pb to red, Zn to purple, Co to blue-violet, and Ag gives a violet precipitate. H.H.S.

Method for reducing tin and antimony prior to titration. B. S. EVANS. *Analyst*, **56**, 171–77 (1931).—Hypophosphorous acid is used as reducing agent instead of Zn or Fe. H.H.S.

Metallic oxides and caustic soda. J. D'ANS AND J. LOFFLER. *Sprechsaal*, **64** [13], 246 (1931).—A method is perfected by which the course of reaction between metallic oxides and alkali hydroxides may be followed quantitatively. In the conversion, $xMeOy + 2NaOH = Na_2\,MexO(y+1) + H_2O$, the quantity of steam developed is determined quantitatively and the quantity of metallic oxides which enters into reaction is ascertained by a suitable analysis method. Only the double oxides richest or poorest in alkali were treated; intermediate compounds, only when they were recognized by their special properties and could be isolated. The following table gives the systems investigated and the compounds determined:

System	Compounds
Na_2O–SiO_2	Na_4SiO_4
Na_2O–ZrO_2	Na_2ZrO_3
Na_2O–TiO_2	Na_4TiO_4, $Na_8Ti_5O_{14}$, $Na_2Ti_6O_{11}$ (?)
Na_2O–CeO_2	Na_2CeO_3
Na_2O–ThO_2	
Na_2O–Al_2O_3	$Na_2Al_2O_4$
Na_2O–Fe_2O_3	$Na_2Fe_2O_4$, Na_2FeO_4
Na_2O–Cr_2O_3	$Na_2Cr_2O_4$ (?), Na_2CrO_4, $Na_2Cr_2O_7$
Na_2O–ZnO	
Na_2O–MgO	

M.V.K.

Name soda-lime-silica compounds. G. W. MOREY AND N. L. BOWEN. *Glass Ind.*, **12** [6], 133 (1931).—The importance of the compound $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ in connection with discussions of either the composition or the devitrification of glass makes a name desirable. The name "Devitrite" has been suggested as suitable because the outstanding characteristic of the compound is its appearance as the primary phase in the devitrification of a large proportion of the glasses of commerce. E.J.V.

Forms of zircon dioxide depending on the treatment. W. M. COHN AND S. TOLKSDORF. *Z. phys. Chem.*, **8** [5], 331–56 (1930); *Sprechsaal*, **64** [9], 170 (1931).—Different zircon-dioxide modifications to be expected on the basis of expansion temperature curves were determined by polarimeter and Debye-Scherrer pictures. Three different modifications were obtained: *C* modification: monoclinic, field of existence from room temperature up to 1000°; lattice constants: $a = 5.21$, $b = 5.26$, $c = 5.37_5$Å, $\beta = 80° 32'$; density 5.56. *B* modification: tetragonal, stable over 1000°, but can be obtained under it; $a = 5.07$, $c = 5.16$Å (Ruff, Ebert), density 6.10. *A* modification: often trigonal or pseudo-hexagonal-rhombic; originates by long heating of $ZrO_2 - C$ to at least 1900°. The modification A_2 lies below 625°; over it, $A_1.a = 3.598$Å, $c{:}a = 1.633$. Substances

containing MgO showed the cubic lattice which must be ascribed to (Ruff, Ebert, see *Ceram. Abs.*, **9** [2], 108 (1930)) Mg_2ZrO_4; the proof of a complete conversion of the substances investigated by the authors into this lattice was not successful. $a = 5.12$Å. The lattice C and B, as well as A_2 and A_1 are enantiotropic; C and A_2 are monotropic. M.V.K.

Tests for zirconium. F. PAVELKA. *Mikrochemie*, **8**, 345–51 (1930); *Analyst*, **56**, 209 (1931).—Carminic acid, yellow in acid solution, changes to purple with Zr. Gallocyanin, red in acid solution, changes to blue with Zr. Ti interferes with both reactions. H.H.S.

Relation between the plasticity of a two component solid-liquid system and the degree of wetting of the solid by the liquid. F. E. BARTELL AND A. HERSHBERGER. *Jour. Rheol.*, **2** [2], 177–204 (1931).—The systems were divided into three groups: (1) A high degree of adhesion exists between solid and liquid. Conclusions: (*a*) An adsorbed film of strongly oriented liquid molecules is firmly held by each solid particle. (*b*) Orientation of liquid molecules extends some distance into the liquid medium. (*c*) The plastic characteristics of such a system are due to resistance to deorientation offered by the oriented liquid molecules. (*d*) The yield value is relatively high and the mobility relatively low in a system in which the forces of attraction between solid and liquid are high. (2) Systems in which a low degree of adhesion exists between solid and liquid. Conclusions: (*a*) The low force of attraction existing between the solid and the liquid leads to flocculation or grouping of the solid particles into clusters. (*b*) The plastic characteristics of such a system are largely dependent upon the friction between the solid particles. (*c*) The yield value is relatively high and the mobility relatively low in a system in which the forces of attraction between solid and liquid are low. (3) Systems in which an intermediate degree of adhesion exists between solid and liquid. Conclusions: The plastic characteristics of such a system are dependent upon a combination of influences, *i.e.*, the orientation of liquid molecules resulting from the force of attraction, solid vs. liquid, the friction between the solid particles resulting from flocculation, and the fluidity of the liquid medium. It is impossible to definitely determine the predominating influence in this case. It is impossible, likewise, to determine with certainty the relation between the plastic characteristics of the pastes and the degree of wetting of the solid by the liquid. G.R.S.

Influence of the proximity of a solid wall on the consistency of viscous and plastic materials. II. G. W. SCOTT BLAIR. *Jour. Phys. Chem.*, **34** [7], 1505–1508 (1930).—The case of a material streaming through a tube and having a layer showing modified consistency constants in the immediate neighborhood of the wall of the tube is discussed. The empirical "correction" constants proposed in the previous paper are expressed in terms of the consistency constants (modified and otherwise) of the material. **III.** R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Jour. Phys. Chem.*, **35** [5] 1212–15 (1931).—A solid wall may modify the consistency of the material at an appreciable distance from it, but the accuracy of the available data is insufficient to enable any reliable estimate to be made of the thickness of the modified layer. Even when its effective thickness is as much as 20% of the radius of the tube, the construction proposed in the first paper for determining the mobility of the material in bulk gives a close approximation to the true value. A full application of the extended treatment must await the development of more accurate experimental methods. For Part I see *Ceram. Abs.*, **9** [5], 383 (1931). G.R.S.

Viscosity and rigidity in suspensions of fine particles. I. Aqueous suspensions. C. M. MCDOWELL AND F. L. USHER. *Proc. Roy. Soc.* [London], **131***A* [817], 409–28 (1931).—The time factor is important in the production of both variable viscosity and of rigidity. The effects of additions of solutions of sodium chloride to the suspensions

were studied. At low rates of shear the effective volume concentration of solid is high and leads to high viscosities, while the disintegration of the aggregates brought about by higher rates of shear causes the previously held liquid to be liberated and thus reduces the effective volume concentration of solid. G.R.S.

Law of elasticity for isotropic and quasi-isotropic substances by finite deformations. H. HENCKY. *Jour. Rheol.*, **2** [2], 169–76 (1931).—Hooke's law concerning the relation between stress and strain is not valid for finite deformations. A law of elasticity is developed which contains in itself the law of Hooke as a special case and is theoretically incontestable. Specializing this law in a manner suggested by the experiments of Bridgeman concerning the compressibility of matter, it is possible to reproduce analytically most of the results of B. A table gives the two coefficients of compressibility, consisting of the modulus of compression, K, and a hypothetical limiting relative volume, ϕ, and a diagram shows the coincidence of formula and experiment. G.R.S.

Mechanism of the coagulation of sols by electrolytes. II. Hydrous alumina sols. H. B. WEISER. *Jour. Phys. Chem.*, **35** [5], 1368–96 (1931).—A study was made of the change in chloride ion concentration and in p_H value during coagulation by the stepwise addition of electrolytes to aluminium sols prepared (1) by peptization of "grown" alumina with $AlCl_3$ and (2) by hydrolysis of $AlCl_3$ and dialysis. For Part I see *Ceram Abs.*, **10** [3], 225 (1931). G.R.S.

Mass analytical determination of hydrofluoric acid. F. H. ZSCHACKE. *Chem. Ztg.*, **55** [26], 246–47 (1931); *Sprechsaal*, **64** [18], 335 (1931).—The Greef method used with success for determining hydrofluoric acid depends on the formation of iron cryolite according to the equation $3Na_2F_2 + FeCl_3 = Na_3FeF_6 + 3NaCl$. With an addition of potassium thiocyanate as indicator one can determine from the red coloring when all the fluorine is used for cryolite and the surplus Fe is no longer present in a complex form. The method is described. M.V.K.

Effect of fine lime on pure clay. ANON. *Brit. Clayworker*, **40** [468], 13 (1931).—Clay itself when heated undergoes its normal decomposition into a mixture of free alumina and free silica at 575°C, water being expelled as steam. At 900°C mullite is formed and the surplus silica is converted into cristobalite at 1200°C. The calcium carbonate on heating to 700°C is converted into quicklime, carbon dioxide being evolved as a gas, the lime showing a wholly different X-ray spectrum from that of the original carbonate. This lime is wholly amorphous. Any free quartz present is converted into β-quartz at 570°C and on prolonged heating at 1200°C some cristobalite is formed. The lime has no effect on the decomposition of the clay in the kilns. The formation of lime-alumina-clay compounds proceeds steadily as the temperature rises and depends on the proportion of alumina present. Most of the reactions occur between solid materials; no sign of fusion occurring below 1100°C. The calcium aluminates and silicates first formed are soluble in hydrochloric acid and in a solution of caustic soda. The porosity of the clay is not affected seriously below 1100°C. At about 1200°C, a eutectic of lime, silica, and alumina is formed and fused. The peculiar mobility of the molten lime silicates makes it difficult to prepare a good stoneware from artificial mixtures of chalk or limestone and clay. R.A.H.

Structure of silicon tetrafluoride. G. NATTA. *Gaz. chim. ital.*, **60** [11], 911–22 (1930).—Solid silicon tetrafluoride was examined by X-ray by the powder method. The lattice of the silicon atoms in the tetrafluoride is cubical with a central body. The side of the elementary cell, equal to 5.41 ± 0.01 Å, and containing 2 molecules SiF_4, is −170°; volume $V = 158.10^{-24}$ cc.; density, 2.17. The tetrafluoride does not seem to be an ionic compound. It has a "lattice of molecules" and belongs to the spatial group O^2. The radius of the neutral atom of fluoride is equal to about 0.50 Å. M.V.K.

Determination and separation of titanium with the aid of 8-hydroxyquinoline.

R. BERG AND M. TEITELBAUM. *Z. anal. Chem.*, **81**, 1–8 (1930).—The Ti solution (150 cc.) is treated with 1 g. of tartaric acid, 0.5 g. of CH_3CO_2Na, and NH_4OH until neutral (phenolphthalein), heated to 60 °C, acidified with 2 to 3 cc. of CH_3CO_2H and treated with a 3% alcoholic solution of 8-hydroxyquinoline until the supernatant liquid is pure yellow. After boiling gently for 10 minutes, the precipitate is collected in a glass filter crucible, washed with hot water, dried at 110°, and weighed as $TiO(C_9H_6ON)_2$. Alternately it may be ignited to TiO_2. In the presence of Al, malonic acid should be used in place of tartaric acid. (*J.I.M.*)

Determination of alkalis. CURT PRUESSING. *Zement*, **20** [16], 360 (1931); *Rock Prod.*, **34** [11], 94 (1931).—P. experimented with the Lawrence Smith method of alkali determination. According to the results, it appears important to determine the exact temperature at which the evaporation of the alkali starts, and to determine if the evaporation temperature is lowered by the presence of ammonium chloride. When a temperature of 500 °C is reached, marked losses in evaporation of the alkali mixture set in. W.W.M.

Determining size of particles of powdered substances. K. KASAI. *Sci. Papers Inst. Phys. Chem. Research* [Tokyo], **13** [242], 135–83 (1930); *Tonind.-Ztg.*, **55** [15], 219 (1931); *Sprechsaal*, **64** [13], 249 (1931).—K. reviews the latest works in which a definition of the grain diameter of particles of irregular shape is given. In the present work, K. studied the relation between the average diameter, the projection surface, and the volume of particles and attempted to establish the hypothesis that every particle is an ellipsoid. Calculated values of the dimensions are compared with the experimental values. A better agreement with the diameter of Stoke was obtained. M.V.K.

Decomposition of alkali chlorides at high temperatures. F. C. GUTHRIE AND J. T. NANCE. *Trans. Faraday Soc.*, **27** [5], 228–33 (1931).—At temperatures above their melting point, the most important factor in the decomposition of LiCl, NaCl, KCl, and CsCl is the concentration of water vapor. The volatility of the chlorides and products of decomposition and their corrosive action on available refractories make it impracticable to carry out quantitative experiments required for the complete elucidation of the nature of the reactions. G.R.S.

Adsorption of substances by fuller's earth. H. J. PHELPS. *Proc. Roy. Soc.* [London], **131***A* [816], 17–30 (1931).—Two types of adsorption take place; that of ionized molecules and that of cations which displace calcium ions from the surface. For solutions of reaction between p_H3 and p_H8, the adsorption of bases by fuller's earth proceeds by displacement of calcium. The greater adsorption of the base at p_H10 is shown to be a property of an aluminium silicate surface. All the adsorption that was observed may be accounted for by the displaced calcium in solutions more acid than p_H7 to p_H8. Aluminium silicate gel, however, will not adsorb the bases at all in solutions more acid than p_H7. The rapid fall of the adsorption in solutions between p_H11 and p_H13 has no parallel in charcoal adsorption and is attributed to a change in the surface itself. This change occurs with the aluminium silicate gel and with fuller's earth, and is a property of a silicate surface. G.R.S.

Heat of ionization of water. FREDERICK D. ROSSINI. Research Paper No. 309; Bur. Stand., *Jour. Research*, **6** [5], 847–55 (1931).—The heat of ionization of water has been calculated by combining the data on heats of neutralization given by Richards and Rowe and the data on heats of dilution recently compiled by Rossini. The value so obtained is corroborated by using the data on heats of neutralization reported by Gillespie, Lambert, and Gibson. For the reaction $H_2O = H^+ + OH^-$, at infinite dilution in water and for the temperature range 10 to 35 °C, the heat absorbed is given by the equation $\Delta H = 13{,}721 - 57.9\ (t - 18) + 0.15\ (t - 18)^2$ g.-cal.$_{18}$ per mole. The uncertainty is estimated to be ±16 calories per mole. Using the factor

4.181 for converting g.-cal.$_{18}$ to absolute joules gives $\Delta H = 57{,}370$ absolute joules per mole at 18°C. See also *Ceram. Abs.*, **10** [4], 307 (1931). R.A.H.

Influence of size of particles of kaolin on filtration of tannin solutions. DE LA BRUERE. *Le Cuir Tech.*, **18,** 444 (1929); *Jour. Amer. Leather Chem. Assn.*, **26,** 166 (1931).—The analysis of chestnut or quebracho extracts is not affected by the size of particles of kaolin used in the filtration. H.H.S.

BOOKS

Textbook of Practical Physical Chemistry. K. FAJANS AND J. WUST. Translated from the German by Bryan Topley. Methuen & Co., Ltd., London. 233 pp. Reviewed in *Trans. Faraday Soc.*, **27** [5], 238 (1931).—The theory is given in the case of each measurement, and such important matters as radioactive transformers, spectrophotometric measurements, ultra-violet spectrography, potentiometric titration, the quinhydrone electrode, etc., are included. The translation is good and the book is one which can be recommended as giving a sound course of practical physical chemistry. G.R.S.

Handbook of Chemical Microscopy. Vol. II. E. M. CHAMOT AND C. W. MASON. John Wiley & Sons, New York. Price $4.50. *Can. Chem. Met.*, **15** [5], 80 (1931).—This volume extends the principles and use of microscopes and accessories dealt with in the first volume. The inclusive field of "microchemistry" is discussed only in regard to those portions of it which involve microscopic qualitative reactions. A discussion of manipulative methods of general character and the methods of applying reagents precedes a systematic study of elements by groups, the detection of anions, and a system for the qualitative analysis of materials of unknown composition. Photomicrographs of most of the common and useful tests are included. For review of Vol. I. see *Ceram. Abs.*, 9 [5], 388 (1930). E.J.V.

Spirit of Chemistry. ALEXANDER FINDLAY. Longmans, Green & Co., Ltd., London. 480 pp. Reviewed in *Trans. Faraday Soc.*, **27** [5], 237–38 (1931).—This volume is intended particularly for those who wish to know something of chemistry as a part of a generous education. G.R.S.

Theoretical Physics. Vol. I. Mechanics and Heat: Newton-Carnot. W. WILSON. Methuen & Co., London. 332 pp. Reviewed in *Trans. Faraday Soc.*, **27** [5], 234–35 (1931).—The declared purpose of this work is "to present an account of the theoretical side of physics which, without being too elaborate or voluminous, will nevertheless be sufficiently comprehensive to be useful to teachers and students." G.R.S.

Electrochemistry of Solutions. S. GLASSTONE. Methuen & Co., Ltd., London. 476 pp. Reviewed in *Trans. Faraday Soc.*, **27** [5], 239–40 (1931).—All of the usual topics appear, but in addition there are chapters on neutralization, buffer action, indicators, amphoteric electrolytes, electrometric titration, overvoltage and passivity, etc., in which modern material not found in the usual textbooks finds a treatment adequate for the purposes of the student. G.R.S.

Spectrum Analysis in Mineralogy. A. A. FITCH. Adam Hilger, Ltd., London. Price 1s 11d. *Mining Ind. Rec.*, **34** [5], 89 (1931).—Methods of analysis based upon types of emission spectra are described as well as those involving the use of absorption spectra. E.J.V.

Physical Properties of the Soil. BERNARD A. KEEN. Longmans, Green & Co., Ltd., London. 380 pp. Reviewed in *Trans. Faraday Soc.*, **27** [5], 233–34 (1931).—This scholarly book is an important addition to the Rothamsted Monographs in Agricultural Science of which series it forms the 5th member. G.R.S.

Annual Tables of Constants and Numerical Data, Chemical, Physical, Biological, and Technological. Vol. VII. Parts 1 and 2, 1925–26. ANON. Reviewed in *Jour. Phys. Chem.*, **35** [5], 1501 (1931); see also *Ceram. Abs.*, **10** [5], 392 (1931). G.R.S.

PATENTS

Production of beryllium, etc. HUGH S. COOPER. U. S. 1,805,567, May 19, 1931. The process comprises heating a beryllium compound in the presence of a chlorinating agent under reducing conditions until a substantially oxygen-free chloride of beryllium is formed, and collecting and electrolyzing the chloride, all under anhydrous conditions.

Producing potassium phosphate. OSCAR KASELITZ. U. S. 1,805,873, May 19, 1931. The process of producing monopotassium phosphate from phosphoric acid and potassium chloride comprising heating potassium chloride with a quantity, in excess of the molecular, of dilute phosphoric acid having a concentration of at least 30% until the hydrochloric acid has been expelled and decomposing the acid salt resulting on cooling of the solution with so much water that monophosphate is separated out and a liquor is formed which is saturated with monophosphate (KH_2PO_4) and the double-salt $KH_2PO_4 \cdot H_3PO_4$.

Making sodium fluoride. ERICH ECKOLDT. U. S. 1,809,476, June 9, 1931. A process of making sodium fluoride from raw materials containing calcium fluoride consisting in mixing raw materials containing calcium fluoride with silica and melting them with potassium carbonate, washing the melt with water, separating silica from the solution obtained by adding potassium silica fluoride and adding sodium carbonate to the remaining solution of potassium fluoride after separating it from the precipitated silica.

Manufacture and production of pure zinc oxide and zinc carbonate. J. Y. JOHNSON. Brit. 347,849, May 13, 1931.

Manufacture of antimony oxides. DEUTSCHE SCHMELZ-U. RAFFINIERWERKE AKT.-GES., AND H. W. GRIMM. Brit. 348,138, May 20, 1931.

Process for converting zircon oxide into a plastic state. DEUTSCHE GOLD UND SILBER-SCHEIDEANSTALT. Ger. 519,796, Dec. 28, 1926; *Tonind.-Ztg.*, **55** [34], 499 (1931).—Zircon oxide is thoroughly mixed the dry way with compounds of zirconium, aluminium, or magnesium which can be hydrolyzed, and, if necessary, with other admixtures as thorium oxide; then molded with the addition of liquids. The objects obtained are afterward treated in the usual manner. Halides such as zirconium tetrachloride, aluminium chloride, and magnesium chloride are used to give plasticity. One to 10% of salts which can be hydrolyzed and sometimes less than 1%, according to circumstances, are sufficient. The dry grinding is done in a mill. M.V.K.

General

Permanent marking of glass and porcelain vessels. H. G. ISBELL. *Chemist-Analyst*, **20** [3], 20 (1931).—A good ceramic ink can be prepared from 1 g. K_2CO_3, 1 g. borax, 2 g. PbO, and 2 g. $Co(NO_3)_2$. Mix with raw linseed oil with possibly a little turpentine, apply with a pen, and heat. (*C.A.*)

Testing resistance to abrasion. S. J. ROSENBERG. *Engineer*, **151** [3915], 105 (1931); for abstract see *Ceram. Abs.*, **10** [1], 5 (1931).
(*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Tests on ceramic materials. O. KALLAUNER. *First Communications New Internat. Assn. for Testing Materials, B*, 263–77 (1930); for abstract see *Ceram. Abs.*, **10** [1], 68 (1931). (*C.A.*)

Economics of the nonmetallic mineral industries. IV. Financing a rock product project. RAYMOND B. LADOO. *Rock Prod.*, **34** [12], 35–36 (1931).—Enterprises often fail from insufficient cash capital because of lack of foresight, or because of excess optimism regarding the actual costs, not merely of building a plant, but of keeping the business afloat until on a profitable operating basis. Going concerns that have been

profitable often fail when consolidated by promoters into an organization with an excess capital structure. For Part III see *Ceram. Abs.*, **10** [7], 521 (1931). W.W.M.

Saving money in the boiler house. ANON. *Brit. Clayworker*, **40** [468], 7–9 (1931).—There are 3 basic boiler losses: chimney, radiation, and ash and unburned coal losses, which cannot be eliminated, but by scientific control can be reduced to a minimum. Such a saving may mean a reduction in present average losses of some 30% in the case of a poor average figure. The first essential for increasing the efficiency of the average boiler plant is to adopt some systematic method of recording the amount of coal consumed and the quantity of steam generated at the boiler stop valve. Methods of measuring are described. Leaky brickwork is a common source of loss in the boiler house. Some losses in steam boilers are (1) unburned fuel in ashes, (2) leakage of air through defective brickwork, (3) faulty valves and fittings, (4) radiation losses, (5) heat losses due to escaping high temperature gases, (6) too high a water level causing priming, (7) loss due to scale in boiler, (8) excessive draft due to dampers being too wide open, (9) use of unsuitable fuel for type of furnace, and (10) chimney losses, *i.e.*, smoke and incompletely burned gases. R.A.H.

Plant operation statistics and economical plant control. J. M. BORCHERT. *Tonind.-Ztg.*, **55** [32], 461–62; [33], 481–83; [34], 497–98 (1931).—B. points out the importance of plant operation statistics and economical plant control. Different methods are given with examples. See also *Ceram. Abs.*, **10** [1], 36 (1931). M.V.K.

Wage incentives mean lower costs and higher pay. LEO SCHWINGHAMMER. *Brick Clay Rec.*, **78** [10], 546–49 (1931).—The foundation of scientific management has been accurate time study and the wage-incentive systems based on this. The general procedure for installing a wage-incentive system and the application of wage incentives in a clay products plant are discussed. E.J.V.

Scientific research from the business point of view. CHRISTOPHER WILSON. *Jour. Soc. Glass Tech.*, **15** [57], 5–12 (1931).—The merits and demerits of having a research organization housed within or without the plant are discussed. The disadvantages of having the organization within the factory are (1) preventing the men on the research staff becoming completely absorbed by difficulties with production, (2) with large concerns having plants in different localities, the research organization would be subdivided, and (3) friction will sometimes arise between research and productive staff, leading to unnecessary delay and expense. The main advantage of having the research within the factory is that the research worker has every opportunity of becoming conversant with intricacies of the industry. The better plan is to organize research apart from the factory, since the research worker would have a broader outlook. G.R.S.

Ultimate responsibilities of research. M. LUCKIESH. *Bull. Amer. Ceram. Soc.*, **10** [6], 143–51 (1931).—Reviewing the beginnings of scientific research, L. discusses some of the achievements due to research and endeavors to point out what it may lead to in the future if properly conducted. Some of the obstacles that must be overcome are enumerated. E.J.V.

Prosperity or hard times? O. W. ROSENTHAL. *Brick Clay Rec.*, **78** [11], 590–96 (1931).—R. discusses the general economic situation and its relationship to the construction industry. He presents as the solution of the present situation the Construction Investment Trust and explains this plan in detail. E.J.V.

Better merchandising. ANON. *Clay-Worker*, **95** [5], 320–21 (1931).—In this review of methods for better merchandising, the subjects touched upon include showing colors and kinds, interesting the home builder, cellars and foundations, landscape work, wayside construction, and enameled face products. E.J.V.

Merchandising common brick. RALPH P. STODDARD. *Clay-Worker*, **95** [5], 328–30 (1931).—To overcome some of the obstacles the brick manufacturer meets in mer-

chandising his product, the Common Brick Mfrs. Assn. is attempting to educate the manufacturer to become a more intelligent merchandiser and more competent to discuss comparative costs of various types of houses. The methods the Association is using are discussed. Illustrated. E.J.V.

Merchandising structural clay tile. J. J. CERMAK. *Clay-Worker*, **95** [5], 330–32 (1931).—The educational program the Structural Clay Tile Assn. is conducting in improving the merchandising of their product includes the entire chain of distribution from the manufacturer to the ultimate consumer. Various phases of this educational program are discussed. E.J.V.

Developing local markets for face brick. ALLAN R. SMITH. *Clay-Worker*, **95** [5], 323–28 (1931).—It has been shown that profitable sales result from giving the buyer what he wants. Some of the plans the American Face Brick Assn. has developed for helping manufacturers and dealers develop business locally are described. Illustrated. E.J.V.

Group or centralized selling. ANON. *Clay-Worker*, **95** [5], 321–22 (1931).—The ideas and some examples of group or centralized selling are explained. E.J.V.

Psychological and financial ills of construction industry. ERNST & ERNST. *Brick Clay Rec.*, **78** [10], 542 (1931).—A general discussion of the two major troubles affecting the construction industry is presented. E.J.V

Ceramics of the Iron Age in Norway. JOHS. BÖE. *Christian Sci. Mon.*, **23** [152], 14 (1931).—Impressions of ceramic art in Norway during the period 300 to 500 A.D., obtained from several thousand museum specimens of ceramic pitchers and pots, are described. The ceramic jars preserved from earlier centuries of plain earthenware and beautiful design are not originally Norwegian but the influence of Denmark and Germany are noticeable, indicating shipping connections with foreign countries. Ceramics from the 3rd and 4th Centuries show no connection with the preceding period. The Norwegian ceramic industry started afresh and developed a production of its own in the 4th Century. E.J.V.

Danger of explosives. W. F. GODEJOHN AND W. DEAN KIEFER. *Brick Clay Rec.*, **78** [10], 550–54 (1931).—Considerable detailed information regarding safe methods of handling explosives from storage facilities, etc., through the actual setting and blasting, is presented. E.J.V.

An ounce of prevention. H. M. TOSTLEBE. *Brick Clay Rec.*, **78** [11], 600–602 (1931).—T. gives practical suggestions on accident prevention. E.J.V.

Ohio clay men discuss research projects. ANON. *Brick Clay Rec.*, **78** [11], 604–606 (1931).—A brief report of the meeting of the Heavy Clay Products Division of the Ohio Ceramic Industries Assn. at Canton, Ohio, May, 1931, is presented. E.J.V.

Leipzig Fair, 1931. ANON. *Tonind.-Ztg.*, **55** [23], 337–39; [24], 357–58 (1931).—Elaborate displays of brick, tile, clinker, whiteware, and stoneware at the Technical and Building Fair in Leipzig are described with various types of machines used in construction. M.V.K.

Reports at the 10th Congress for Industrial Chemistry in Liège, September, 1930. ANON. *Tonind.-Ztg.*, **55** [29], 432 (1931).—Among the reports read were: M. P. LAZAREFF on "The plasticity of solid materials"; R. DUBRISSAY on "Argillaceous suspensions"; A. SILVERMAN on "Progress in production of glass in America"; P. ERCULISSE on "Best chemical composition of cement"; G. BATTA on "Destruction of concrete by water"; G. BAIRE on "Experiments on the decomposition of concrete by different industrial products"; J. MALETTE on "Analytical chemical determination of the constituents of the setting agents in mortars"; M. GAMBEY and G. CHAUDRON on "Physical and chemical tests on some refractory materials." M.V.K.

German building exposition. ANON. *Tonind.-Ztg.*, **55** [37], 537 (1931).—This

issue contains several papers dealing with the German building exposition at Berlin. Not only the different types of building materials and entire buildings with modern rooms, etc., are exhibited but also machines for building purposes. W.M.C.

Electrochemists discuss ceramics at Birmingham meeting. ANON. *Chem. Met. Eng.*, **38** [5], 264–66 (1931).—Papers were presented on the application of electrochemistry to the manufacture of porcelain, glass, silicon carbide, and other refractories. G.R.S.

Ceramic Society in Germany. ANON. *Pottery Gaz.*, **56** [648], 844–48 (1931).—A description of the tour taken by the Pottery, Refractories, and Building Materials Sections of the Ceramic Society through Germany is described. Illustrated. E.J.V.

Visit of the English Ceramic Society to Ph. Rosenthal & Co., Inc., Germany. ANON. *Sprechsaal*, **64** [21], 393–94 (1931).—The English Ceramic Society on their recent trip through Germany visited the plant of Ph. Rosenthal. While at the plant, Rosenthal spoke to the Society on the international situation of the ceramic industry especially emphasizing the high duties of the different countries. W.M.C.

Developing salesmanship. ANON. *Pottery Gaz.*, **56** [648], 830–36 (1931).—A detailed report of the pottery and glassware assistants' educational trip through the potteries in Stourbridge and North Staffordshire by 18 students is given. Illustrated. E.J.V.

Program of studies and tests for silicate engineers in the Technical High School Fredericiana in Baden, Germany. EBERHARD ZSCHIMMER. *Sprechsaal*, **64** [14], 263–65 (1931). M.V.K.

BOOKS AND REPORT

Pocketbook of Electrical Rules and Tables. MONRO AND JAMIESON. J. B. Lippincott Co., Philadelphia, Pa., 1931. 765 pp. Price $4. Reviewed in *Elec. World*, **97** [20], 922 (1931).—This handbook has now reached its 23rd edition which is sufficient proof of its accepted value. Originally intended as a handbook for engineers and electricians engaged on communication problems, it was later extended to include information on practically every branch of electrical engineering. G.R.S.

Introduction to Ceramic Industries. H. N. BOSE. *Ceram. Ind.*, **16** [6], 560 (1931); for review see *Ceram. Abs.*, **10** [1], 81 (1931). W.W.M.

Trends in the production and uses of granite as dimension stone. OLIVER BOWLES AND PAUL HATMAKER. Bur. Mines, *Rept. of Invest.*, No. 3065, 21 pp.—The report describes general economic conditions from 1906 to 1928 and outlines trends in the industry by states, discusses its problems, and suggests means of improvement and expansion. R.A.H.

PATENTS

Treating clay. WILLIAM R. JEAVONS AND MAHLON J. RENTSCHLER. U. S. 1,808,231, June 2, 1931. The herein-described process of treating clay which consists in dissolving barium hydrate in water free from carbon dioxide and pugging a definite proportion of such solution into the clay.

Vitrified argillaceous product. WILLIAM B. PINE, JOSEPH B. SHAW, AND MYRIL C. SHAW. U. S. 1,809,214, June 9, 1931. A vitrified argillaceous product in which the percentage of easily fusible constituents is too low to constitute a porcelain, and having about 10 to 30% of binding material which has been fused and a percentage of pores less than the percentage of pores in any vitrified argillaceous product which could be produced from the same argillaceous material by wet molding, and vitrifying by the standard method heretofore employed.

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

WALTER P. SUTER MYRTLE M. FRENCH	Art	A. E. R. WESTMAN DOROTHY A. TEXTER	Refractories	HOWELLS FRÉCHETTE AMOS P. POTTS	Structural Clay Products
BRYAN A. RICE W. N. HARRISON	Enamel	E. H. FRITZ H. M. KRAMER	White Wares	L. E. RIDDLE V. V. KELSEY	Materials and Equipment
G. W. MORRY LOIS PURDY TURNER	Glass	H. G. SCHURECHT GAIL R. TRUMAN	Terra Cotta		

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Vol. 10 **August, 1931** **No. 8**

EDITORIALS

VITRIFIED TERRA COTTA[1]

BY PAUL E. COX

An undergraduate student was employed for three years in three terra cotta plants as a piece worker in plaster shops, as assistant in the glaze laboratory, and as fireman on a tunnel kiln. On his return to college he commented that in that period he had seen the firing treatment of terra cotta lowered from that which produced a decently hard product to one so soft that the grog would readily fall out when a piece would be broken in handling. He understood that the terra cotta firms were meeting the architect's demands for color by cutting down the kiln temperatures to be able to use the soft majolica glazes.

The architects already find fault enough with terra cotta, and regardless of what the majority of plants may do, all will suffer from a low quality product of any one of the producers.

Last winter a fire broke out in an automobile paint shop. The establishment was a large one with big stocks of supplies. A terra cotta building

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received February 13, 1931.

was across the street, the façade of which the insurance adjuster had cleaned. The terra cotta had not before this been cleaned. It was grimy from soft coal smoke. Where the slip coating had been well fired the terra cotta cleaned up as brightly as new material, but about one-third of the ashlars had been soft fired and the grime had penetrated too deeply to be removed.

It was apparent that had the terra cotta been uniformly fired the job would have been uniformly dirty or uniformly clean after the cleaning, and a considerable group of business men would not have lost faith in terra cotta. In the course of this controversy a man was brought out from Chicago who previously had given preference to terra cotta but who now seriously questions its value.

Iowa has a superior store which deals in fine ceramics from all over the world. The writer makes use of this store as an inspection trip laboratory. The manager of Brinsmaids, Ferd. Schmidt, a practical glassworker from Bohemia, is proud to be able to state that America leads in underglaze work. He likes to point out the fact that American hotel china makers have not been afraid to make better tableware by resorting to high firing and to face the limitations imposed by the higher fire methods. They have been rewarded by having markets that have learned that quality can be depended upon.

Higher firing means increased costs. Notwithstanding this the writer believes that if the architects and owners can be assured of the same uniformly high quality in terra cotta that the hotel and restaurant men have learned to rely on in china, terra cotta, ultimately, will not be a competitor of cut stone, artificial stone, or any other material which cannot, by the very nature of it, do what terra cotta does for the architect.

The hard architectural stoneware of the Sèvres factory is well known. Charles F. Binns has displayed colorful hard stoneware pottery for many years. The Art Division, at the Detroit Meeting of the AMERICAN CERAMIC SOCIETY, had the fine hard stoneware from Royal Copenhagen on display. Taxile Doat in his book, Grand Feu Ceramics, tells the whole story of the product called "grès." The Grand Palais in Paris has a stoneware frieze, and the fountain of Bernard Palissy near the church of St. Germain-des-Pres is colorful. These have endured.

The writer has worked with the identical materials used in the Palissy fountain and has found even better materials in the United States. For example, the off-grade flint clays are ideal for this sort of production. The glazes are those of the porcelain kilns and the crazing problem is not difficult to handle. The color palette, while limited, yet is ample as shown by our high-fired floor and wall tile.

A vitrified porcelain or stoneware would yield a product that would stand on a higher plane than cut stone; it would be colorful; it could be easily

cleaned; it is capable of development in plastic lines and mass rather than having the stiff and hard lines of cut stone; it would be more durable than stone; and it would not be imitated by any other decorative building product.

If French grès costs more to make it is worth more and, with the right kind of salesmanship, this superior product ought to take a place in the mind of the public as secure as that enjoyed by our hotel china, which does not sell in competition with soft-fired goods, because its buyers have learned that they cannot afford to use any other than the best.

IOWA STATE COLLEGE
AMES, IOWA

A MORATORIUM IN UNDERGRADUATE SCHOOL TRAINING

This subject has been discussed occasionally but does not seem to be either desirable or not possible. There are reasons, however, for the suggestion.

It is gratifying, however, that most of the collegiate ceramic departments are putting more emphasis on research and postgraduate studies in ceramics than on undergraduate studies in ceramic courses. In two cases at least, this plan was made by deliberate intent. In other schools, it may have resulted from a scarcity of applicants for the undergraduate courses of study.

It has been the policy of this editor when asked to counsel regarding a new collegiate ceramic department to discourage degree courses and to encourage the establishment of a laboratory for ceramic research, particularly on the ceramic materials of the state in which the college is located and in the interest of the ceramic industries of the state. There has been an emphatic discouragement of establishing courses for the training of undergraduates in ceramics.

An undergraduate course of study for the few who insist on such a course in ceramic technology or engineering is an excellent provision but to encourage a large number to enroll in the course contributes very little to the advancement of the ceramic arts, science, and technology.

The point is not that there is an excess of graduates from ceramic degree courses and an overcrowding in the industrial field, but rather that the need of proved and applicable information is greater than the need of inexperienced graduates. There is an increasing demand in ceramics for men who have a broader training in the scientific fundamentals.

If our ceramic schools would give more stress to opportunities in ceramics for graduate physicists, chemists, engineers, architects, and artists with postgraduate training in ceramics, our schools would contribute much more

largely to industrial ceramics than by turning out ceramic graduates without a broad foundation preparation.

Having fewer students in undergraduate ceramic courses would release more money and technical men of the teaching staff for the investigation of ceramic problems.

In the early years departmental appropriations and staff additions were granted on the basis of the number of undergraduates in the course. Some of this ancient policy may still exist in the universities, but surely nowhere as insistently as in years past. In any event, the medical and law colleges have shown the way to convince university authorities of the fallacy of such a gage of money and staff needs of a collegiate department.

With the backing of the ceramic profession and industry it would be possible and certainly desirable that those ceramic departments that now have large undergraduate enrolment should establish a maximum limit of the number of pupils admitted to the undergraduate degree courses.

Selection of students admitted to the ceramic course could well be made from those who have completed at least two years of a prescribed pre-ceramic training in the science fundamentals and cultural studies. This would make ceramics a six-year course and on par with medical courses.

By limiting the number admitted to the ceramic undergraduate courses, more incentive and encouragement could naturally be given to graduates of other courses to take post graduate work in ceramics.

This is a problem which the Committee on Education of the AMERICAN CERAMIC SOCIETY should consider. It might be well for the SOCIETY to adopt a policy and formulate recommendations to the universities. The Medical Association has worked out a scheme that gives a positive control in the collegiate training of medics in the interest of the medical profession.

It has given medical schools and the graduates of those schools a credit rating for attainments such as our ceramic schools must acquire if their graduates shall not suffer as they now do in the ceramic industries in comparative effectiveness and ability with the chemists, physicists, and engineers who are being employed in ceramic industries in increasing numbers.

ACTIVITIES OF THE SOCIETY

F.A.Cer.S. ARE CORRECT INITIALS FOR FELLOWS†

The Editor takes this opportunity to extend his regret over an error in publishing the report of the Committee of Fellows appointed to select the proper initials to be used after a Fellow's name. These initials, F.A.Cer.S., went through the Editor's office in page proof correctly and were later changed by a printer's assistant as they were about to go on the press.

Readers of the SOCIETY publications are asked to make a note of this correction on pages 245 and 246, July *Bulletin*, so that the incorrect initials will not be inadvertently followed later in the year.

SUMMARY OF PROCESS MEETING, WHITE WARES DIVISION*

SUMMARIZED BY R. F. GELLER

(1) Papers Presented At the Cleveland Meeting of the AMERICAN CERAMIC SOCIETY, the White Wares Division devoted one session to papers and round table discussion of plant processes and technical control methods. (*a*) The first paper, by J. H. Weis,[1] elicited a short discussion regarding power requirements and machine speeds, which is now available in the publication.

(*b*) The reading of the second paper, by H. B. DuBois[2] on "A Proposed Standard for Feldspar Fusion Trials," resulted in an interesting and instructive exchange of opinions concerning the sampling and testing of feldspar shipments. No data have been collected to show the effect of variations in firing time on cone deformation but apparently the method of packing is carefully controlled and it is thought important that producer and consumer standardize on a method of packing to avoid difficulties in duplicating tests. So far, only hand packing has been used, but a mechanical vibrating device was suggested. The importance of properly sampling a shipment was stressed, although no details of methods used were given other than obtaining small batches from 200-lb. samples by means of some automatic splitting device. The discussion also brought out the importance of observing the change in diameter as well as in height of the test cone.

(*c*) The third paper presented by G. A. Wills on "A Trial for Testing Porcelain Bodies and Body Materials on a Laboratory Scale," described a test specimen used primarily to control the effect of the feldspar on the warpage and porosity of the product. The test had not been correlated with production results sufficiently well to serve as a basis for determining whether or not a certain raw material would affect the body sufficiently to make it unsuitable for production. It was being used to show whether or not a test feldspar was better or worse than another feldspar, arbitrarily taken as standard, with respect to warpage during the firing. Naturally, other constituents of the body could cause warpage but, other ingredients and the methods being maintained constant, it was assumed that relative variations in warpage could be charged to the variable

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† See "Report of Committee on Rules Concerning Fellows," p. 245, July *Bulletin*, also last line of paragraph (6), page 246, July *Bulletin*.

* Held February 27, 1931, Cleveland, Ohio.

[1] "Granular Ground Feldspar with a Uniformly Low Iron Content," *Jour. Amer. Ceram. Soc.*, **14** [5], 413 (1931).

[2] The following papers listed have not yet been given publication in the *Journal of the American Ceramic Society*.

which in this case was the feldspar. It was also pointed out that in comparisons of this kind careful consideration should be given to the free quartz content of the several feldspars tested.

(*d*) The fourth paper, on "Notes on a Year's Observation of a Casting Slip in Production," by G. A. Wills, presented the valuable results of a carefully conducted series of observations of casting slip behavior in production. Viscosity of slip, relative humidity of the atmosphere, percentage shop losses, kiln losses, etc., were tabulated at weekly intervals. Losses due to changes in relative humidity could be largely avoided by controlling the "wetness" of the molds. Although no data had been collected on casting rate, the opinion was expressed that this could be controlled suitably by the proper substitution of "fast" and "slow" clays. Also, the slip may be "slowed up" by further deflocculation, but it is not practicable to do the opposite. Viscosity was believed to be controlled by the "silicate," temperature of slip, and its specific gravity.

(*e*) R. A. Snyder's paper on "Progress of Fluidity of Porcelain Bodies," was presented but elicited no discussion.

(*f*) R. G. Mills's paper on "Solution of the Modulus of Rupture Equation by Means of a Simple Four-Variable Chart," was based on rectangular specimens. Inasmuch as results of studies have shown that values for transverse strength may be duplicated within closer limits when determined on round bars, the suggestion was made that a chart be prepared for round bars and that the desirability of using round bars be called to the attention of the Committee on Standards of the AMERICAN CERAMIC SOCIETY.

The meeting was then opened to general discussions of plant control methods.

(2) Plasticity or Mobility Plasticity or mobility is generally measured by deformation of a cone or cube under a constant weight, or depth of penetration of a plunger actuated by a spring or weight, and observation of either the penetration or the force required to cause penetration. Wires cutting through the extruded pug or wheels pressing on the surface under a known weight were suggested for automatic record. Watt meters on the motor driving the pugmill were not considered suitable as a means of controlling the consistency of the extruded body, a constant power input not being equivalent necessarily to a constant "pug." In summarizing, it appears that the devices in use are more or less satisfactory in any one plant to furnish relative batch-to-batch values.

(3) Filter Pressing It was the opinion of several present that the pressure used in filter pressing and the rate at which the pressure is built up are very important factors in efficient operation. The use of pressure recording devices, and controlled pressure and time of operation, may lead to worthwhile savings. The values given varied from 50 minutes at 130 lb. to 3 hours at 70 lb., depending on the nature of the body used. Slight flocculation of the slip in the blunger may permit the water to flow more readily through the deposited clay and thereby speed up the pressing. An added advantage of the pressure recorder is that it will indicate whether or not the pump is operating properly. The question of the rate of building up pressure was discussed in some detail, the opinion being expressed that a gradual increase effected the greatest ultimate saving in time. One schedule was as follows: 20 to 25 lb. for 15 to 20 minutes, then 60 to 80 lb. for a time, finishing at 100 to 110 lb., with a total pressing time of approximately 80 minutes. Requests for information regarding compressed air vs. pumps for filter presses resulted in an interesting exchange of opinion.

(4) Storage of Raw Materials Several plants are going to appreciable expense to store raw materials systematically. The usual scheme is to store a number of shipments in such a way, *e.g.*, horizontal layers, that when drawn on for use, a cross-section can be taken which is a blend of those shipments. The pro-

vision of sufficient space to permit complete control testing of a pile or bin of material before putting it into plant processes was recommended.

(5) Control of Slip In one plant a series of observations indicated a relation between the viscosity (as measured with the Mariotte tube) and the specific gravity. A clever device was described for quickly obtaining a relative specific gravity value. The device consists of two parallel glass tubes, about $^1/_2$ inch in diameter and any desired length, depending on the accuracy desired, which are joined at the top to the same mouthpiece. To make the test, one tube is dipped into a container of water while the other dips into an adjacent container of the slip. Suction is applied at the mouthpiece until the water rises to a certain mark. The height of rise of the slip in the other tube then serves as a measure of its relative specific gravity.

Another important means of slip control, which may be applied also to glazes, is to provide sufficient cistern capacity to permit completely filling and adjusting one cistern before using any slip out of it. It was also mentioned in the discussion that where deflocculating is necessary, at least 24 hours and preferably two or three days should be allowed for reactions to reach equilibrium.

It was thought that much of the warpage trouble encountered in hollow casting is caused by pulling the cores or emptying the slip too soon.

The meeting was well attended throughout the session and apparently met with the hearty approval and active support of a large majority present. The exchange of opinions and comparison of plant control methods was most encouraging to those present interested in the promotion of united efforts for furthering the welfare of the whiteware industry.

GLASS DIVISION SUMMER MEETING

The Glass Division of the AMERICAN CERAMIC SOCIETY will hold its summer meeting at Old Point Comfort, Va., September 11–14. The program is as follows:

Leave Baltimore 6:30 P.M. Friday, September 11, from Pier 10, Light St., by Old Bay Line boat. Dinner on boat. Arrive at Old Point Comfort, Va., Saturday morning. Stay at Chamberlain Hotel Saturday and Sunday (American plan). Leave Old Point Comfort by boat Sunday night. Dinner on boat. Breakfast Monday on boat, arriving in Baltimore 7:30 A.M., September 14.

The Division will have the use of the dining room on the boat after 8:30 P.M. for an informal or business meeting. A business meeting will be held Saturday night in a private dining room at the Hotel.

Expenses

Round trip transportation and outside staterooms (two persons to a room), running hot and cold water in each room. Dinner on going trip, dinner and breakfast on return trip.

Stay at Hotel Chamberlain at Old Point Comfort from Saturday morning to Sunday night, two persons to a room, all meals included, total cost, $18.95.

There will be plenty of bathing, fishing, golf, etc.

OFFICERS OF THE AMERICAN REFRACTORIES INSTITUTE

The following officers and directors of the American Refractories Institute were elected at the Annual Meeting, June 3, at St. Louis, Mo.:

President: W. B. Coullie, General Sales Manager, Harbison-Walker Refractories Co., Pittsburgh, Pa.

1st Vice-President: W. J. Westphalen, Vice-President and General Manager, Laclede-Christy Clay Products Co., St. Louis, Mo.
2nd Vice-President: A. P. Taylor, President, The Chas. Taylor Sons Co., Cincinnati, Ohio
Treasurer: C. C. Edmunds, Treasurer, McLain Fire Brick Co., Pittsburgh, Pa.
Secretary: Dorothy A. Texter, 2218 Oliver Bldg., Pittsburgh, Pa.

DIRECTORS

Geo. A. Balz, President, Seaboard Refractories Co., Perth Amboy, N. J.
J. E. Lewis, President, Harbison-Walker Refractories Co., Pittsburgh, Pa.
John R. Sproul, President, General Refractories Co., Philadelphia, Pa.
A. P. Green, President, A. P. Green Fire Brick Co., Mexico, Mo.
J. D. Ramsay, President, North American Refractories Co., Cleveland, Ohio
H. L. Tredennick, President, Haws Refractories Co., Johnstown, Pa.
J. H. Cavender, Vice-President and Sales Manager, North American Refractories Co., Cleveland, Ohio
A. P. Taylor, President, The Chas. Taylor Sons Co., Cincinnati, Ohio
S. M. Kier, Vice-President, General Refractories Co., Salina, Pa.

LOCAL SECTION NEWS

California Section[1]

On Monday evening, June 8, the California Section of the AMERICAN CERAMIC SOCIETY held a barbecue at the rustic lodge of L. H. Wilson of the Batchelder-Wilson Co. The staff of the Batchelder-Wilson Co. acted as hosts for the evening.

NECROLOGY

Rufus H. King

Word has been received of the sudden death of Rufus H. King of New York City on April 1, 1931. His death was the result of injuries received when he was struck by an automobile.

Mr. King had been associated with the Robeson Process Corporation of New York City since 1912. He was a graduate of Yale University and served in both the Spanish-American and the World wars.

Mr. King became a member of the AMERICAN CERAMIC SOCIETY in 1926 and his death will be keenly felt by his many friends in the SOCIETY.

William Angus McIntyre

The death of Captain W. A. McIntyre occurred on May 21, 1931, in England, after a brief illness. Captain McIntyre, who was 43 years of age at the time of his death, was graduated at the Royal College of Science with the degrees of B.Sc. and A.R.C.Sc. in 1915.

He was known to many in the clay industries and made noteworthy contributions to the investigation of clay products, combining a sound scientific knowledge with full realization of the practical aspects of the problems with which he was called upon to deal. He was a frequent contributor to the English ceramic journals and trade press.

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[1] John S. Lathrop, *Secretary.*

Otto Metzner

The death of Otto Metzner, superintendent of Rookwood Pottery for twenty-six years, occurred on June 24, 1931. He was born in Indianapolis, Ind., in 1866. Both Mr. Metzner and his father, Adolph Metzner, were pioneers in the pottery and ceramic industries of this country and became associated at Hamilton, Ohio, in what was known as the Hamilton Tile Works. In 1895, this business was converted into a pottery, where Mr. Metzner held a position as ceramist and superintendent until 1899. He then spent six years at Roseville, Ohio, where he held the same position with McCoy Pottery.

OTTO METZNER

Twenty-six years ago Mr. Metzner became superintendent of Rookwood Pottery, Cincinnati, Ohio, and held this position until his death. His influence is reflected in everything connected with Rookwood; his many years of practical experience, blended with a keen mind and a wonderful personality, made him capable and loved by all who knew him. He often accomplished the seemingly impossible with almost startling ease and quickness. His death is a great loss to the pottery and facience industries, but he built well and the influence of his work will aid those who carry on.

Mr. Metzner had been a member of the AMERICAN CERAMIC SOCIETY since 1906, and was a quiet but faithful worker, always interested in the development of the SOCIETY and its promotion of ceramic interests.

NEW MEMBERS FOR JUNE

PERSONAL

Kende Eleőd, Chateau Verthamont, Par Isle, Hte. Vienne, France.
Joseph O'Connell, Melbourne, Australia.
Kohei Ohishi, Nippon Sheet Glass Co., Ltd., Sumitomo Bldg., Kitahama, Osaka, Japan.
Francisco Sangra, 35 Carretera de Port, Barcelona, Spain.

Membership Workers' Record

The Membership Workers' Record for June is as follows: Office, 4.

ROSTER CHANGES FOR JUNE

PERSONAL*

Alexander, H. W., 215 Salem Ave., Apartment 19, Dayton, Ohio. (204 Ceramics Bldg., Urbana, Ill.)
Atkins, Kenith D., Martinsville, Ill. (502 E. John St., Champaign, Ill.)
Dunn, F. B., Monroe St., Conneaut, Ohio. (Empire Bldg., Pittsburgh, Pa.)

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* Addresses within the parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Edwards, F. Moorland, Robinson Clay Products Co., Mogadore, Ohio. (37 W. Lane Ave., Columbus, Ohio)
Ellis-Anwyl, Robert H., 580 E. Town St., Columbus, Ohio. (22 W. Falls St., New Castle, Pa.)
Fulcher, Gordon S., Administration Bldg., World's Fair, Chicago, Ill. (Corning Glass Works, Corning, N. Y.)
Holz, H. Paul, Philadelphia Electric Co., Philadelphia, Pa. (Membership transferred from Jay O. Achenbach)
Jacobs, W. M., 550 N. McKean Ave., Kittanning, Pa. (Charleroi, Pa.)
Johnson, Gerald L., Sioux City, Iowa. (142 Gray Ave., Ames, Iowa)
Keller, W. D., North Kansas City, Mo. (604 S. Clark St., Mexico, Mo.)
Lyon, Kenneth C., La Harpe, Ill. (408 E. John St., Champaign, Ill.)
MacDougall, Robert, National Enameling & Stamping Co., Granite City, Ill. (Coonley Mfg. Co., Cicero, Ill.)
McBerty, R. K., 1213 Dallas Ave., Tarentum, Pa. (150 Frambes Ave., Columbus, Ohio)
Moncrieff, James W., P. O. Box 93, East Liverpool, Ohio. (328 W. 9th Ave., Columbus, Ohio)
Pearson, J. Donald, Chicago Vitreous Enamel Product Co., Cicero, Ill. (325 N. Washington, Ottumwa, Iowa)
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NOTES AND NEWS

The Ohio State University
Columbus, Ohio
July 3, 1931

General Education Board,
Division of Industrial Art,
New York City, N. Y.

THE GENERAL EDUCATION BOARD RESEARCH IN TABLEWARE DESIGN AT OHIO STATE UNIVERSITY

Gentlemen:

One year ago the fund granted by the General Education Board for the creation of a scholarship at the Ohio State University in ceramic design applied to tableware became available.

At this time we are presenting a brief report of the administration of this grant during its first year. As parts of this report we are sending you the following documents:

(1) A reprint from the *Journal of the American Ceramic Society* for June, 1931,

entitled "Tableware Design Research at Ohio State University." This published report of progress states briefly what has been done and outlines the general program which was formulated at the AMERICAN CERAMIC SOCIETY Meeting in Cleveland last February.

(2) A set of blue prints of the typical shapes of a dinner service (round shape) which are drawn to union specifications. A set of these prints has been sent to all tableware manufacturers. A similar set of drawings of square dinnerware shapes conforming to union specifications has been prepared. Blue prints of these will be sent out during the coming month. These two sets of drawings supply fundamental reference material which the factories have not had in definite form. They should be of real value to designers and business executives in the tableware plants as an aid in the discussion and planning of new shapes.

(3) A statement of expenditures to July 1, 1931. It will be noted that the entire amount of $4000 has not been used this year. We have purposely conserved all that we could with the object of having funds available for a more efficient attack on certain problems which we plan to work out next year involving the employment of expensive skilled labor. There is also a part of the work done this year which is still to be published and distributed to manufacturers and will use up a certain amount of the present surplus.

Manufacturers have shown much interest in the study that we are carrying on. We have been particularly fortunate in obtaining the advice and close coöperation of Mr. Frederick H. Rhead, art director of the Homer Laughlin China Company of Newell, W. Va. Mr. Rhead has given a great deal of thought to our project and his counsel and constructive criticism have been invaluable to Mr. Bogatay. The manufacturers have been most willing to help by giving us the freedom of their plants for study of table-ware problems. Fortunately, for the success of our undertaking, the holder of the fellowship, Mr. Bogatay, is well liked by the factory men with whom he comes in contact. This is an important factor in getting the interested coöperation without which a project such as ours would be sadly handicapped.

We believe that a good foundation has been laid upon which there will be built up, during the remaining year of the study, a valuable contribution to the industry. This will comprise not only fundamental reference material such as the blue prints of round shapes (published) and square shapes (completed but not yet published), but also we plan next year to do considerable development work on specific design problems and decorative methods. Mr. Bogatay has already made promising beginnings in work of this sort, both in the development of simple embossed patterns and in decalcomania and underglaze print patterns, several of which are being proofed.

The undertaking is well under way. Paul Bogatay in his nine months of service has shown himself to be an able, intelligent designer, thoroughly interested in his work. He has acquired a good fundamental knowledge of his field of effort. A program has been approved and is being worked out. Expert guidance from Mr. Rhead and others is helping to steer the activity in practical channels. The industry is interested. We have confidence that the complete results of the study will justify the faith and support which the General Education Board has given to the project.

Respectfully submitted,

ARTHUR E. BAGGS,
Professor of Ceramic Art

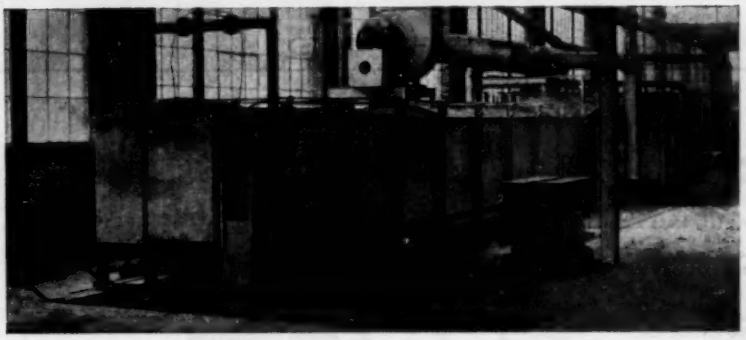
General Education Board Fellowship Tableware Design Research

Statement of Receipts, Expenditures, and Balance as of June 30, 1931

Receipts		
General Education Board		$4000.00
Expenditures		
Paul Bogatay (salary October to June, inc.)	$1500.00	
Paul Bogatay (traveling expense)	377.58	
Arthur E. Baggs (traveling expense)	170.76	
John C. Wheatley (special instruction in decorative processes)	238.65	
H. E. Brittingham (services in making tracings)	60.00	
The O. Hommel Co. (laboratory supplies)	32.64	
University Book Store (supplies)	34.60	
Photography Dept. O. S. U. (photographs)	62.10	
L. Reusche and Co. (laboratory supplies)	6.29	
J. H. Jansen Co. (book, Decorative Vorbilder)	14.40	
Paul Bogatay (pottery supplies)	2.58	
Total Expenditures		2499.60
Cash Balance		$1500.40
Outstanding Orders		
University Press (letterheads and envelopes).		10.50
Free Balance		$1489.90

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	August 31–Sept. 4	Buffalo, N. Y.
American Gas Assn.	October 12–18	Atlantic City, N. J.
American Society of Mechanical Engineers	September 7–9	Kansas City, Mo.
American Society for Steel Treating	September 21–25	Boston, Mass.
Electrochemical Society	September 2–5	Salt Lake City, Utah
National Assn. of Manufacturers	October 5–9	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors' Assn.	December 1–3	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	October	Trenton, N. J.
Optical Society of America	October 22–24	Rochester, N. Y.
Sand-Lime Brick Assn.	February 3–4, 1932	Washington, D. C.
Taylor Society, Inc.	December 2–4	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12, 1932	Rochester, N. Y.



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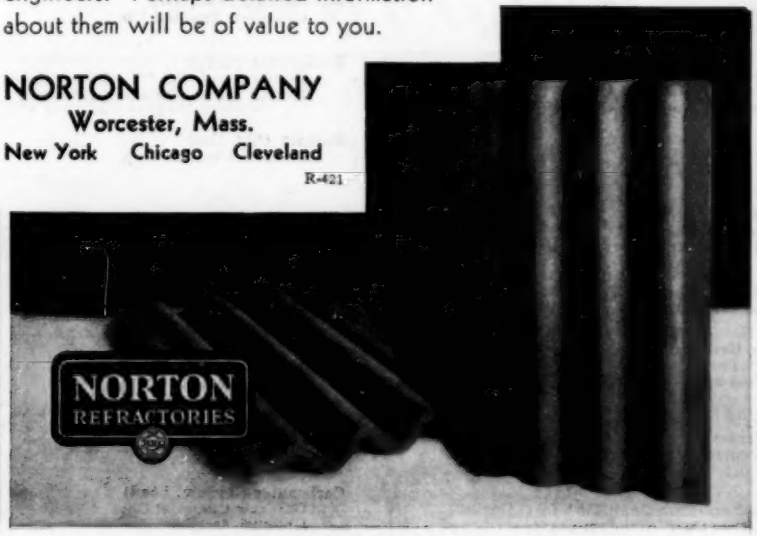

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Kilns (Electric)
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L

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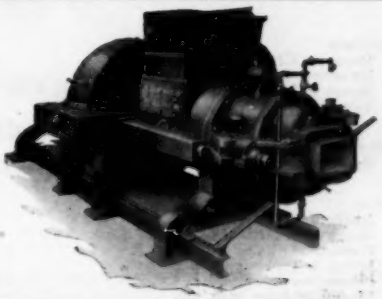

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O

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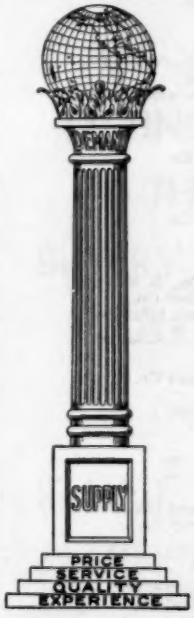

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Sodium Fluoride
Harshaw Chemical Co.
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Hommel, O., Co.
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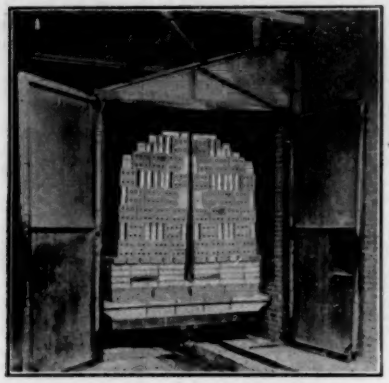

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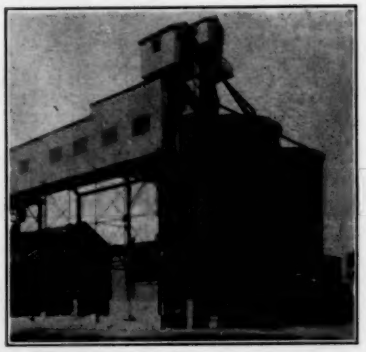

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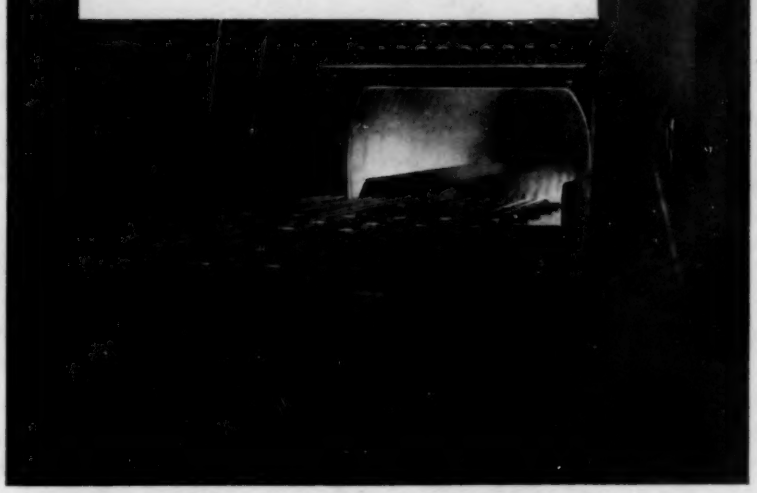

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